

From THE DEPARTMENT OF PUBLIC HEALTH SCIENCES
Karolinska Institutet, Stockholm, Sweden

**IMPLEMENTING PREVENTION OF MOTHER-
TO-CHILD TRANSMISSION OF HIV IN
DAR ES SALAAM, TANZANIA**

**HUMAN RESOURCES, CLIENT AND PROVIDER
SATISFACTION AND COST-EFFECTIVENESS**

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**Karolinska
Institutet**

Stockholm 2017

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Published by Karolinska Institutet.

Printed by EPRINT AB 2017

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ISBN 978-91-7676-867-9

Implementing Prevention of Mother-to-Child Transmission of HIV in Dar es Salaam, Tanzania: Human Resources, Client Satisfaction and Provider Satisfaction and Cost-effectiveness

THESIS FOR DOCTORAL DEGREE (Ph.D.)

The public defence for the doctoral degree (PhD) will be held at the Karolina lecture room, Widerströmska huset, Karolinska Institutet, Solna.

Tuesday December 5th 2017, at 9 a.m.

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This thesis is dedicated to the memory of my dear father who worked hard to educate his children and education has made me the person I am today.

ABSTRACT

Despite advancement in global efforts to prevent mother-to-child transmission of HIV (PMTCT), more work needs to be done to protect children from HIV transmission particularly in eastern and southern Africa. The integration of PMTCT into routine antenatal care (ANC) services is one cost-effective intervention for averting mother-to-child transmission (MTCT) of HIV. However, adherence to PMTCT services in ANC and throughout the breastfeeding period, when the infant is at risk of MTCT, is limited due to stigma, lack of knowledge and weak health systems in countries like Tanzania.

The main aim of the thesis was to assess patient and provider satisfaction in PMTCT clinics, the potential for task-shifting and cost-effectiveness aspects of uptake of and adherence to the PMTCT programme in Dar es Salaam, Tanzania.

Four studies were conducted based on data collected in Dar es Salaam in 2014 and 2016. In **Paper I**, we conducted a cross-sectional survey using Likert scale questions administered face-to-face to 595 pregnant women living with HIV and attending ANC services. In **Paper II**, we used a self-administered survey to 213 PMTCT providers. In **Paper III**, we used direct-time motion observations to assess time spent on each PMTCT task, and in **Paper IV**, we conducted a cost-effectiveness analysis from a providers perspective using health outcomes which were based on a secondary data analysis of de-identified health system data including a cohort of 2309 women newly diagnosed with HIV who delivered a baby between August 2014 and May 2016 in Dar Es Salaam. Descriptive statistics were used to summarize data in all four papers and logistic regression models were used to identify predictors of satisfaction/dissatisfaction (**Papers I and II**).

Only 8% of patients were dissatisfied with PMTCT services, in particular with poor provider communication skills (OR 4.9, 95% CI 1.8 ± 1 3.4), low capacity to understand client concerns (OR 5.7, 95% CI 2.3 ± 14.0) or if the hospital visits took over 2 hours (OR 2.3, 95% CI 1.1 ± 4.7) (**Paper I**).

More than half of health care providers were dissatisfied with their current job and one third had turnover intentions. Dissatisfaction with the job was influenced by: low salaries (OR 5.6, 95%CI 1.2-26.8), unreasonably long working hours (OR 3.2, 95% CI 1.3-7.6), unclear job descriptions (OR 4.3, 95% CI 1.2-14.7) and poor safety measures (OR 4.0, 95% CI 1.5-10.6). Turnover intention was influenced by: poor job stability (OR 3.7, 95% CI 1.3-10.5), lack of recognition from one's superior (OR 3.6, 95% CI 1.7-7.6) and inadequate feedback (OR 2.7, 95% CI 1.3-5.8) (**Paper II**).

Nurses spent more time on the first antenatal and postnatal clinic visit (54 minutes, 95% CI 42–65 and 29 minutes, 95% CI 26-32) than follow-up visits (15 minutes 95% CI 14-17) and 13 minutes, 95% CI 11-16). A large proportion of this time (84%-100%) could be task-shifted to community health care workers. If these tasks were shifted to lower cadres, the average cost-saving per patient visit ranges from US\$ 0.4 to 1.3 (**Paper III**).

Most (91.3%) pregnant women living with HIV do not attend ANC in the first trimester, and more than half make fewer than 4 visits during the entire pregnancy. The overall MTCT rate was 2.8% (95% CI 2.2%-3.6%) at 12 weeks of life. More visits protected against HIV transmission: The MTCT rate was 4.8% (95% CI 3.6%-6.4%) for women with fewer than 4 visits and only 1% (95% CI 0.5%-1.7%) for women who made at least 4 visits. The incremental cost-effectiveness ratio was US\$ 336.37 per MTCT averted when at least 4 visits were made, which is less than one year's cost of HIV treatment for an HIV-positive infant initiating ART (**Paper IV**).

In conclusion, patient satisfaction was influenced by good patient-provider interaction but providers themselves were not satisfied with their job for various reasons including high workload. Thus, interventions such as task-shifting can potentially improve job satisfaction, quality of care and retention in care and contribute to the elimination of MTCT in Tanzania and other resource limited countries. Furthermore, early uptake of and retention in ANC/PMTCT care can protect children from being born with HIV and also reduce future treatment costs for Tanzania.

LIST OF SCIENTIFIC PAPERS

- I. Predictors of Patient Dissatisfaction with Services for Prevention of Mother-To-Child Transmission of HIV in Dar es Salaam, Tanzania. PloS one. 2016 Oct 21; 11(10): e0165121.
- II. Job satisfaction and turnover intentions among health care staff providing services for prevention of mother-to-child transmission of HIV in Dar es Salaam, Tanzania. Human Resources for Health. 2017 Sep 6;15(1):61.
- III. The potential of task-shifting in scaling up services for prevention of mother-to-child transmission of HIV: a time and motion study in Dar es Salaam, Tanzania. Human resources for health. 2017 May 26; 15(1): 35.
- IV. Health care costs associated with clinic visits for prevention of mother-to-child transmission of HIV (PMTCT) in Dar es Salaam, Tanzania. (Submitted manuscript)

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LIST OF ABBREVIATIONS

3TC	Lamivudine
ABC	Abacavir
AIDS	Acquired immunodeficiency syndrome
ANC	Antenatal care
ART	Antiretroviral therapy
AZT	Azidothymidine
CD4	Cluster of differentiation 4
CHAI	Clinton Health Access Initiative
CHW	Community Health Worker
CTC	Care and treatment clinic
DNA PCR	Deoxyribonucleic acid polymerase chain reaction
FTC	Emtricitabine
EFV	Efavirenz
EMTCT	Elimination of mother-to-child transmission of HIV
GA	Gestation age
GDP	Gross domestic product
GPRM	Global Price Reporting Mechanism
HIV	Human immunodeficiency virus
HEI	HIV- exposed infant
ICER	
LPV/r	Lopinavir/ritonavir
MDH	Management and Development for Health
MSD	Medical Store Department
MTCT	Mother-to-child transmission of HIV
MUHAS	Muhimbili University of Health and Allied Sciences
NVP	Nevirapine
PEPFAR	President's Emergency Plan For AIDS Relief
PMTCT	Prevention of mother-to-child transmission of HIV
SDG	Sustainable Development Goals
TasP	Treatment as prevention
TDF	Tenofovir disoproxil fumarate

UNAIDS	Joint United Nations Programme on HIV/AIDS
UNICEF	The United Nations Children's Fund
WHO	World Health Organisation

1 GENERAL BACKGROUND

1.1 HIV/AIDS

Acquired Human Immunodeficiency Syndrome (AIDS) was recognized as a new disease in 1980. The disease was present among previously healthy homosexual young men who presented with unusual infections such as *Pneumocystis carinii (jiroveci)* pneumonia, extensive mucosal candidiasis, and multiple viral infections (1). In early 1983, the human immunodeficiency virus (HIV) was isolated and in 1984 HIV was identified to be the causative organism for AIDS (2). HIV causes gradual depletion of cluster of differentiation 4 (CD4) positive T-cells, leading to progressive weakening of the immune system, increasing the susceptibility to opportunistic infections (3). The virus exists in two types; HIV-1 and HIV-2, but HIV-1 causes most of HIV infections worldwide (4). Infection with either type can lead to the development of AIDS, but HIV-1 is more infectious and HIV-1 infection progresses faster than HIV-2 (5).

HIV infection is detected by the presence of HIV-specific antibodies in serum or plasma (for adults and children above 18 months of age) or the presence of the virus by nucleic acid detection using polymerase chain reaction (PCR) or p24 antigen testing. The main transmission mode of HIV is through sexual contact (80%). Mother-to-child transmission (MTCT) accounts for 10% of new HIV infections, while the remaining new infections are due to blood-borne exposure such as unsafe blood transfusion, sharing contaminated needles and other sharps (6). The proportions differ a lot between regions and population groups. Thus combinations of prevention strategies addressing these modes of transmission are recommended (7-9). Such strategies should at least involve providing education to reduce unsafe sex, syringe and needle exchange, screening of blood (10) and the cascade of strategies recommended for prevention of mother-to-child HIV transmission (PMTCT) (9).

1.2 EPIDEMIOLOGY OF HIV INFECTION

1.2.1 Global situation

Globally in 2016, there were 36.7 [30.8-42.9] million people living with HIV, including 1.8 [1.6-2.1] million people who became newly infected. About 1 [0.83-1.2] million people died from AIDS-related illnesses in the same year (11). This translated into a 32% and 16% global reduction in AIDS-related deaths and new HIV infections respectively between 2010 and 2016. The epidemic is worse in eastern and southern Africa, home to over half of all people living with HIV in the world, with 59% of them being women (11).

To combat the HIV epidemic, in 2014 the Joint United Nations Programme on HIV/AIDS (UNAIDS) launched a fast-track approach for ending the global AIDS epidemic by 2030 (12). The approach involves a set of targets known as 90-90-90, to be achieved by 2020. These targets require that 90% of people living with HIV should know their HIV status; 90%

of those who know their HIV-positive status should receive treatment; and 90% of people on treatment should have suppressed viral load (12). Substantial progress has already been made and in 2016 more than two thirds of all people living with HIV in the world knew their HIV status, of whom 77% were accessing antiretroviral therapy (ART) and 82% of people on treatment had undetectable viral load (13). World Health Organization (WHO) defines viral load suppression in low and middle-income countries as a viral load of < 1000 RNA copies per ml (14).

The progress towards ending HIV epidemic in eastern and southern Africa was significant in 2016. In this region, about 76% of people living with HIV knew their status, of whom 79% were receiving ART, and 83% of those on ART had achieved viral suppression (13). However, these are estimates for only those who know their HIV status. Out of all people living with HIV, this translates as only 60% being on ART, and only half of them having achieved undetectable viral load (13).

1.2.2 HIV and AIDS situation in Tanzania

The total population of Tanzania was estimated at 53 million people in 2015(15). Nearly half of the population (45%) consists of young people aged less than 15 years (16). The population was projected to be 52 million in 2017 (15). Tanzania has an average real GDP growth rate of 7.8 %, and is the third country after Ghana (9%) and Ivory Coast (7.9%), showing the fastest growing economy in Africa (17). Nevertheless, Tanzania remains a low-income country, with 28% of the population living below the poverty line of less than 2 US dollars per day (15). In addition, a Gross Domestic Product (GDP) per capita of 979 US dollars in 2016 is less than that of its neighbouring countries such as Kenya (1143 US\$) and Zambia (1622 US\$) (18). Despite prevailing poverty, the Government of Tanzania has a strong commitment to improving the health of the population and the country has made significant progress in many key health indicators. According to the Tanzania population and housing census conducted every ten years, life expectancy increased from 51 to 61 years between 2002 and 2012 (16). Furthermore, infant mortality declined from 95 to 46 deaths per 1000 live births and under-five mortality declined from 153 to 67 per 1000 live births (16). In the fight against the HIV epidemic, the Government of Tanzania receives support from foreign donors who contribute about 97.5% of the treatment costs. The major donor is the President's Emergency Plan for AIDS Relief (PEPFAR), which finances about 80 % of HIV activities in the country (19). To reduce donor dependency, an AIDS trust fund has been established with the aim of financing nearly one third of the national response by 2018(19)

The first three cases of AIDS were diagnosed in 1983 in the Kagera region, and by 1986 all regions of Tanzania had reported AIDS cases (20). The HIV epidemic in the country is heterogeneous with geographical and population variability. In 2012, HIV prevalence ranged from 1% in Pemba, 6.9% in Dar es Salaam to a high of 14.8% in Njombe (21). The epidemic is mostly attributable to heterosexual transmission (80%), followed by MTCT (18%) and blood-borne infections, which account for 1.8% of all HIV infections (21). Scaling-up access to ART has minimized the impact of the epidemic, such that, between

2004 (when access to ART was limited) to 2016 (when 63% of adults had access to ART), prevalence dropped from 7.1 percent to 4.7 percent (11). Furthermore, between 2010 and 2016, a 53% reduction in AIDS-related deaths and 18% reduction in new HIV infections were reported (11). Despite the decline, in 2016 there were still 1.4 [1.2-1.6] million people living with HIV, including 55000 [42 000–67 000] who were newly infected in Tanzania (11). The current progress shows that, by 2016 only 70% of 1.4 million people living with HIV knew their status, and of these 88% had initiated ART. However this represented only 63% of all people living with HIV who were on treatment and the records for those who had achieved viral suppression were not available (13). Thus, additional efforts are required to achieve the 90-90-90 targets and to end the HIV epidemic in Tanzania by 2030.

Table 1. Key indicators for the United Republic of Tanzania

Indicator	Number /Percent
Total population (2015)	534 704 000
Population proportion (%) under 15 years	45.2
Total fertility rate (number of children per woman)	5.2
GDP per Capita (2016)	USD 979
Life expectancy in years (average; Male: Female)	61.8 (M; 59.8:F; 63.8)
Literacy rate (%) among adults 15 years and over	73
Median age at first marriage for women age 25-49 (years)	19.2
Women age 15-19 who are mothers or currently pregnant (%)	27
Total demand for family planning (%)	61
Births delivered in a health care facility (%)	63
Children (12-23 months) who received all basic vaccinations (%)	75
Children under five (%) who are stunted (moderate or severe)	34
Infants exclusively breastfed in the 1 st 6months of life (%)	59.2
Neonatal mortality (per 1 000 live births)	25
Infant mortality (per 1 000 live births)	43
Under 5 mortality (per 1 000 live births)	67
Maternal mortality ratio (per 100 000 live births (2015))	398
Physician density (per 1 000 population)	0.03
Nursing and midwifery personnel density (per 1 000 population)	0.45
Total expenditure in health as % GDP (2014)	5.6
Private expenditure in health as % of total expenditure on health	53.6
Government expenditure on health as % of total expenditure	12

Adopted from key indicators. Tanzania national bureau of statistics. Statistics for development: Retrieved from <http://www.nbs.go.tz> Copyright National Bureau of Statistics 2017.

1.3 PREVENTION OF HIV

While a cure or an effective HIV vaccine is not yet available, a combination of behavioural, structural and biomedical interventions targeting the main methods of HIV transmission remains an important aspect of HIV prevention (7-9).

Behavioural interventions focus on providing context-specific health education to the communities to promote low-risk behaviours known to be effective in decreasing new HIV infections (10, 22, 23). These interventions include promoting safe sex behaviour, increasing condom use, decreasing the number of sexual partners, delaying the onset of sexual intercourse, improving treatment adherence among people living with HIV, sexual education of youth and improving communication with partners regarding safer sexual practices (8, 24).

Structural interventions focus on modifying the structural context where health is produced and reproduced to influence the availability, acceptability and accessibility of the materials or environments needed to maintain safe behaviours (25). This involves complex interventions to change the social, economic, political and environmental factors that have an impact on resilience and vulnerability to HIV (26). Harm reduction, such as needle and syringe exchange, is among the structural interventions shown to be effective in reducing the spread of HIV among people who inject drugs (27, 28).

Biomedical interventions such as male circumcision (29), barrier methods such as condom (30), antimicrobial products (31), HIV treatment as prevention also referred to as TasP (32), pre-exposure prophylaxis (33) as well as PMTCT (34), represent significant breakthroughs in the field of HIV prevention. However, since none of these interventions is 100% effective, a combination of them is essential for improved outcomes. The success of preventive actions is dependent not only on behavioural factors affecting the uptake of and adherence to various protective interventions but is also affected by health system structures and access to effective biomedical interventions (35).

1.4 TREATMENT OF HIV

There is no cure for HIV, but ART can control HIV, revert AIDS and greatly improve survival and quality of life for people living with HIV (36, 37). Thus, when effectively taken, ART can lead to adequate and sustainable viral load suppression, improve CD4 T-cell counts and halt the clinical progression of the HIV infection (38).

ART are grouped into classes according to how they act, and the selection of regimen includes three medicines (triple therapy) from at least two different HIV drug classes. These include nucleoside reverse transcriptase inhibitors, non-nucleoside reverse transcriptase inhibitors, protease inhibitors, fusion inhibitors, entry inhibitors and integrase strand transfer

inhibitors (39). WHO makes generic recommendations that are adapted and implemented in low-and middle-income countries.

WHO recommends rapid ART initiation (within 7 days of diagnosis) to all people living with HIV after a confirmed diagnosis and following the clinical assessment, an approach referred to as “test and treat” (14). For adults (including pregnant women) and children older than 10 years, WHO recommends an ART drug combination of tenofovir (TDF), and either lamivudine (3TC) or emtricitabine (FTC) and efavirenz (EFV) as the first-line treatment regimen for adults (14). The recommended first-line ART regimen for children between 3 and 10 years is a combination of Abacavir (ABC) and 3TC and EFV whereas for children younger than 3 years, a combination of ABC or Azidothymidine, also known as Zidovudine (AZT)+ 3TC+ Lopinavir/ritonavir (LPV/r), is recommended (14).

1.5 MOTHER-TO-CHILD TRANSMISSION OF HIV

1.5.1 Key MTCT concepts

MTCT of HIV refers to the transmission of HIV from a pregnant woman living with HIV to her child during pregnancy, labour, delivery or breastfeeding. The risk of transmission is mostly influenced by the high maternal plasma viral load and deterioration of maternal disease stage. This is made worse by vaginal delivery, prolonged rupture of membranes, prematurity and breastfeeding, factors that expose the infant to maternal blood, vaginal fluids and breast milk contaminated with the virus (40). MTCT accounts for 90% of HIV infections in children, making it the main route of transmission among the children below 15 years (9). In the absence of any intervention, about 15-45 % of HIV-infected mothers will transmit infection to their unborn children, 5-10% during pregnancy, 10-15% during labour and delivery and 5-20% during breastfeeding (9). However, if these women have access to antiretroviral therapy, the risk of transmission drops to less than 5% (41).

Women of childbearing age still account for nearly half of the adults living with HIV in the world, with only 60% of them accessing ART (11). New infections among children contribute about 11% of all incident HIV infections and 13% of total HIV-related deaths globally (11). Infants living with HIV have higher rates of disease progression to AIDS and death than older children and adults, even with high CD4 lymphocyte counts (42). The mortality is so high that without treatment almost one third (35.2%) will die before their first birthday and slightly over half (52.5%) will die before they reach two years of age (43). Since PMTCT is the most effective way to avoid HIV infection and prevent deaths in children; it is considered an essential part of maternal, new born, and child health care. Furthermore, by eliminating MTCT (EMTCT), defined as a reduction in final MTCT rate to $\leq 5\%$ among breastfeeding populations, and $\leq 2\%$ among non-breastfeeding populations (44), the dream of an HIV-free generation will be achieved.

1.5.2 Prevention of mother-to-child transmission of HIV

WHO recommends a strategy for comprehensive PMTCT globally, with four prongs which are to: (i) prevent HIV infection among women of childbearing age, (ii) prevent unintended pregnancies in women living with HIV, (iii) prevent HIV transmission from women to their infants and (iv) provide care, treatment and support for mothers living with HIV, their infants and families. Thus PMTCT promotes the health-related sustainable development goal (SDG), that requires countries to ensure healthy lives and promote well-being for all at all ages, and in target 3.3 to end the AIDS epidemic by 2030 (45). These approaches are challenged by several factors including weak health systems that limit access to HIV testing, prevention and treatment in many settings (46, 47). Furthermore, about 38% of pregnancies that occur each year globally are unplanned (48) and the unmet need for contraception remains high especially in sub-Saharan Africa (49). However, the opportunity for prevention exists as the majority (85%) of pregnant women globally attend antenatal care (ANC) clinics at least once during their pregnancy (50). This provides opportunity to initiate ART for preventing MTCT and promoting the survival of infants, and their families as well as decreasing transmission in communities.

1.5.3 The global history of PMTCT

The history of PMTCT can be traced back to 1983, when the paediatric HIV infections were linked to the MTCT, and the only preventive strategy was to provide testing for HIV and advise women living with HIV to avoid pregnancy (51). Since then PMTCT has undergone substantial advancement based on scientific evidence from research (**Table 2**). A huge breakthrough was marked in 1994, when AZT was found to reduce MTCT by approximately two thirds (52) and became the first available antiretroviral agent for PMTCT. However, the cost and complexities of using AZT made it less feasible for resource-limited settings, where safe and acceptable breastfeeding alternatives are limited (53). In the early 2000s, a second major discovery made Nevirapine prophylaxis (single dose at the onset of labour and infant single dose within 72 hours of life) a feasible option for both breastfeeding (54, 55) and non-breastfeeding populations (56). Based on the available evidence (53, 57), WHO's recommendation was modified in 2004 to accommodate extended use of AZT from 28 weeks of pregnancy to prevent MTCT and lifelong ART for women with a CD4 cell count less than 200 per μL (57). In 2006, in addition to the use of AZT during pregnancy, WHO added seven days of AZT to the mother and to the infant (58). This became possible following the availability of ART in many low-income countries supported through PEPFAR funding. However, this type of early MTCT prevention was limited to a few weeks after delivery and the long-term efficacy of PMTCT was reduced by subsequent MTCT during breastfeeding (59, 60). To prevent emerging drug resistance against antiretroviral drugs, WHO updated its guidelines again in 2010 in order to discourage the use of single drug regimens aiming to prevent resistance. Furthermore, among other things, the 2010 guidelines encouraged universal access and longer duration of triple ART during pregnancy (from 14 weeks of gestation) and during the breastfeeding period, which was extended to at least 12 months

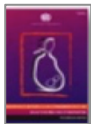





(61). The two proposed options were option A (maternal AZT during pregnancy, coupled with infant Nevirapine during breastfeeding) and option B (maternal ART during pregnancy and breastfeeding) (61)

Subsequently, more evidence suggested it was possible to achieve EMTCT with the use of both perinatal and postnatal ART (62, 63). UNAIDS and PEPFAR proposed new ambitious goals to reduce the number of new HIV infections occurring through MTCT by 90% and halve HIV-related maternal deaths (64). Priority was given to the 22 countries that accounted for 90% of pregnant women living with HIV worldwide including Tanzania (65).

The global progress in reducing MTCT has been dramatic and WHO has already validated that some countries in Europe and Latin America have eliminated the MTCT of HIV and syphilis (66-68), a proof that MTCT can be eliminated in real-life settings. The success in these countries was driven in part by their effort to ensure that women had early access to prenatal care, HIV and syphilis testing together with their partners, treatment for women who tested positive, safe infant feeding and treatment for their infants if they became infected (66-68). However, progress is slow in the Global Plan priority countries where health system challenges still limit the real-life effectiveness of PMTCT interventions (69). More than 1.4 million pregnant women globally were living with HIV in 2016 but only 77% accessed ART, and about 160 000 new infections occurred among children that year (69). Thus, the availability of guidelines and effective PMTCT medicines alone will not be enough to achieve EMTCT. Thus, a strong commitment is required to scale up the PMTCT service uptake, retention as well as efforts to support adherence to ART throughout pregnancy and breastfeeding (70), and for life if we are to fulfil the aspirations and benefits associated with PMTCT Option B+ .

Barriers towards reaching the EMTCT target include the continued lack of functioning health systems that can ensure equitable and universal access to antenatal and post-natal care. However, the strengthening of health systems in Tanzania and elsewhere in sub-Saharan Africa is an on-going albeit too slow process, limiting the real-life effectiveness of PMTCT interventions and hampering progress towards the EMTCT target across the Global Plan priority countries (69). Another critical component at health system level is the integration of maternal and child health care with HIV and PMTCT care, an important step towards improving the uptake of health services and better health outcomes (71). The process of integration of PMTCT into standard routine ANC is moving faster than the strengthening of other components of the health systems in countries like Tanzania.

Table 2. Milestones of WHO PMTCT guidelines development

Year of recommendation	PMTCT recommendation (prophylaxis)	Recommendation for life long ART
 2001	AZT during 4 weeks of pregnancy + AZT+ 3TC during labour, or single dose Nevirapine (NVP) at the onset of labour	NONE
 2004	AZT starting at 28 weeks of pregnancy + single dose NVP at the onset of labour	CD4<200 cells per μ L
 2006	AZT starting at 28 weeks of pregnancy + single dose NVP at the onset of labour +AZT/3TC for 7days post delivery	CD4<200 cells per μ L
 2010	Option A AZT starting at 14wks of pregnancy until 7 days post-delivery + infant NVP from birth till end of breastfeeding Option B Combination ART starting at 14 weeks of pregnancy until end of breastfeeding and infant NVP for the first 6 weeks of life	CD4<350 cells per μ L
 2013	Option B or B+ Lifelong ART for all HIV+ pregnant women starting as soon as possible after diagnosis	CD4<500 cells/ mm^3
 2015	Test and treat all people living with HIV (including non-pregnant women)	ALL people living with HIV

Adapted from publications on mother-to-child transmission of HIV. Retrieved from <http://www.who.int/hiv/pub/mtct/en/> Copyright World Health Organization 2017.

1.5.4 Progress in PMTCT towards EMTCT of HIV in Tanzania

Tanzania is among the 22 Global Plan priority countries targeted for EMTCT of HIV because it is among the countries that accounts for 90% of pregnant women living with HIV in the world and a high number (86 000) of annual deliveries also occur among these women (69). Tanzania began offering PMTCT services in 2000, starting with five tertiary care hospitals located in the Dar es Salaam, Kilimanjaro, Mwanza, Mbeya and Kagera regions (72). This started as a pilot programme initiated by the Tanzanian Ministry of Health in collaboration with the United Nations Children's Fund (UNICEF) to assess the feasibility of integrating PMTCT within routine ANC (72). Subsequently, integrated ANC/PMTCT services were scaled up in all the regions in the country. The national PMTCT guidelines were adapted from the generic WHO guidelines and the subsequent revisions are based on the WHO updates (**Table 2**). Currently, Tanzania is implementing Option B+ (73) as well as a “test and treat” approach (14).

Although Tanzania falls short of the EMTCT goal, by 2016 it had made significant progress towards EMTCT as it had achieved a 69% MTCT reduction since 2009 when the Global Plan target, aiming at 90% reduction by 2015 was set (69). Furthermore, the MTCT rate at the end of breastfeeding has gone down to 8% but not yet to the Global Plan target level of less than 5% (69). The progress so far can be attributed to the use of effective PMTCT regimens including Option B+ and also increased access to ART by pregnant women living with HIV (11). In addition, so-called integrated ANC/PMTCT services are provided in 93% of all health care facilities in the country and about 98% of pregnant women attend ANC at least once during pregnancy (74). Pregnant women in Tanzania also have adequate knowledge about PMTCT (75) and almost all pregnant women who receive HIV testing and counselling consent to testing (75, 76). Since these women are already accessing ANC, the health system should support them to enter and successfully migrate through the PMTCT cascade (**Figure 1**) until the final HIV status of their infants is known (77).

WHO recommends that infants exposed to HIV be tested at the first postnatal visit usually when they reach four to six weeks of age or at the earliest opportunity thereafter, and that those who are infected should start treatment immediately (77). However about half of HIV-infected infants still do not receive an HIV test as recommended (69). Thus it is crucially important to strengthen health systems to ensure the uptake and continuity of migration through the PMTCT cascade in order to move towards EMTCT (78).

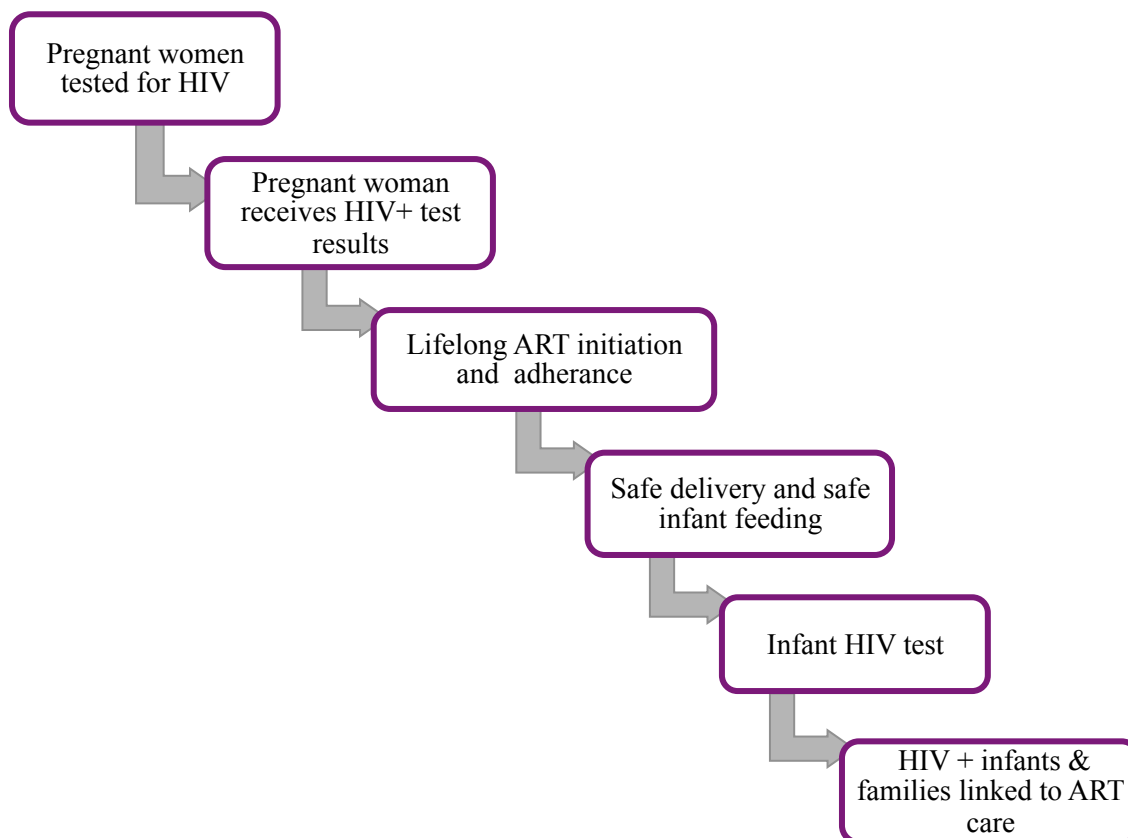


Figure 1. The PMTCT cascade. Adapted from the Tanzania guidelines for comprehensive care services for prevention of mother-to-child transmission of HIV and keeping mothers alive, by the United Republic of Tanzania 2013. by ministry of health and social welfare

1.6 IMPLEMENTING PMTCT WITHIN THE EXISTING HEALTH SYSTEMS

1.6.1 Framework of efficient health system building blocks

The service delivery and utilization of PMTCT services can be largely affected by health system factors, and made worse by co-existing social and cultural factors (46, 79). WHO recognizes health service delivery as a pillar of a health system and the main output is to ensure the delivery of quality services that are accessible, equitable, safe, and responsive to the needs of the consumers (80). Thus to deliver such services, WHO recommends health system strengthening in all six of its building blocks (**Figure 2**), including (i) Service delivery, (ii) Health workforce, (iii) Health information system, (iv) Access to essential medicines, (v) Financing and (vi) Leadership/Governance (80).

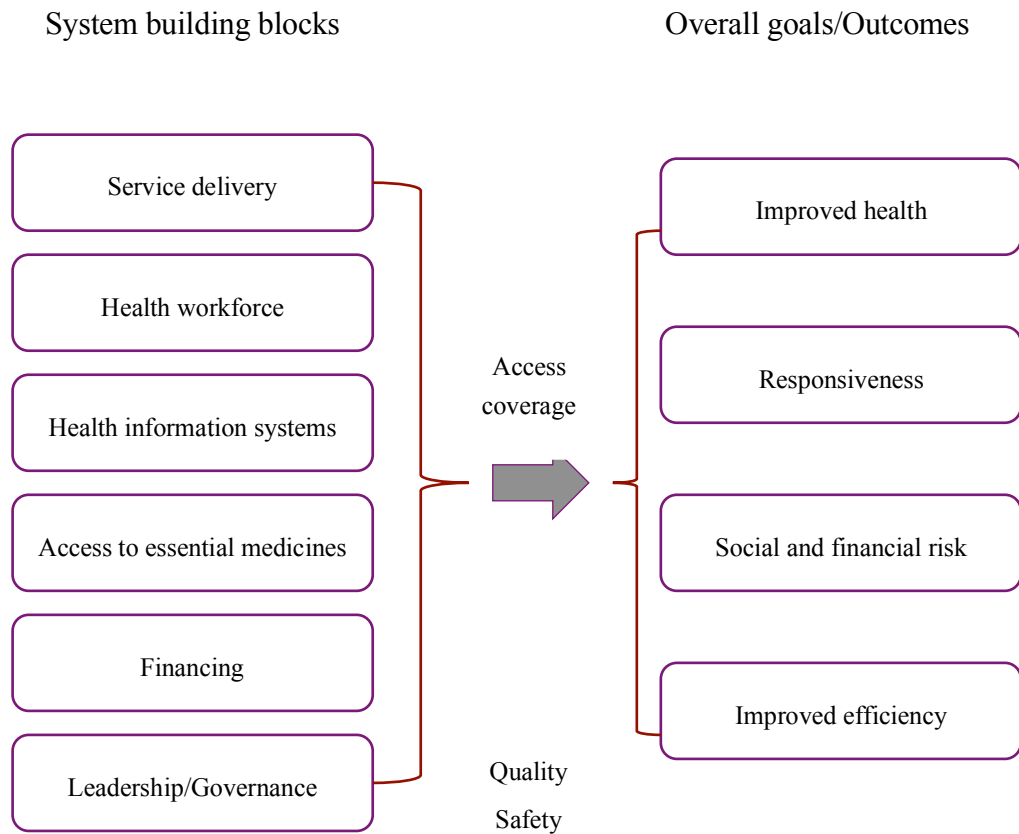


Figure 2. The WHO Health systems framework. Reprinted from Everybody's business: strengthening health systems to improve health outcomes: WHO's framework for action (p.3), by the WHO Document Production Services, Geneva, Switzerland Copyright World Health Organization 2007.

1.6.2 Tanzanian health system

1.6.2.1 Health system organization

The health system in Tanzania is organized in a hierarchical system that mimics the government structures of leadership. The different levels of services are organized in a pyramid system, on top of which there are specialized hospitals providing tertiary level care, while at the bottom are the primary health care facilities (dispensaries, health centres and district hospitals) where most ANC/PMTCT services are provided (**Figure 3**). At the community level, there is a village health unit where a community health worker (CHW) provides basic preventive health services within the community (81).

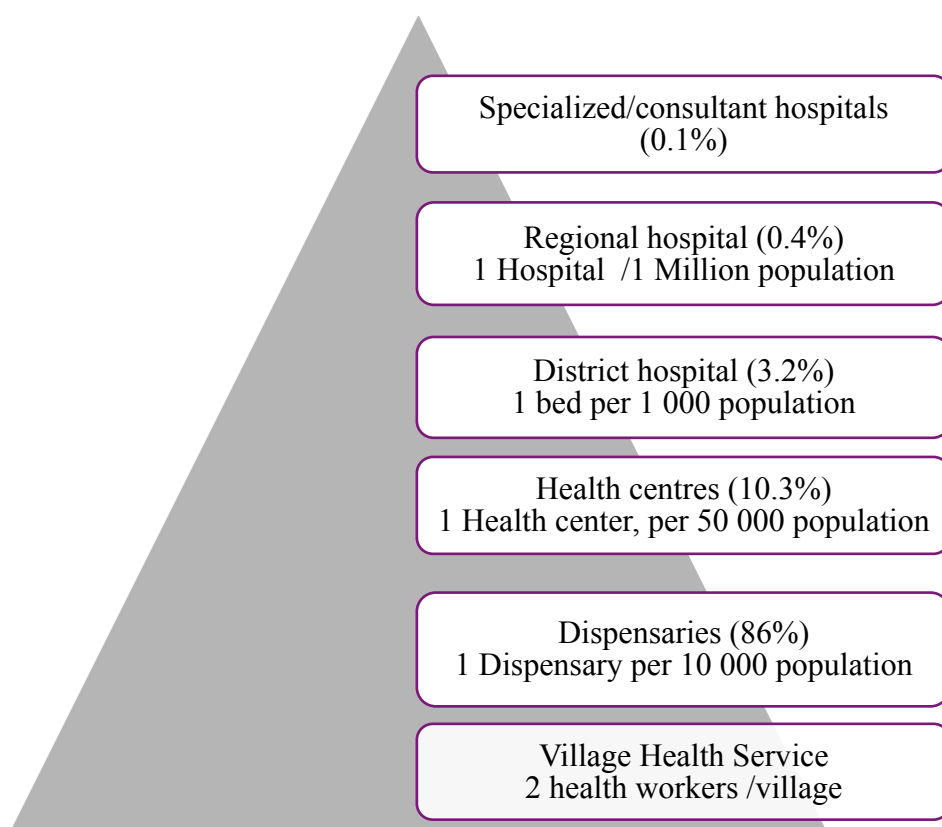


Figure 3. Organizational structure of health care delivery system in Tanzania and the proportion of available health care facilities. Adapted from The United Republic of Tanzania Human resource for health country profile 2013 by ministry of health and social welfare retrieved from [http://www.tzdp.gov.or.tz /fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_2/health/ Key_Sector_Documents/HRH_Documents/Final_Country_Profile_2013.pdf](http://www.tzdp.gov.or.tz/fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_2/health/Key_Sector_Documents/HRH_Documents/Final_Country_Profile_2013.pdf)

1.6.2.2 Health service delivery

Tanzania has about 6549 dispensaries, 718 health centres and 252 hospitals (public and private) throughout the country. It is estimated that 1.5 health care facilities serve at least 10 000 people (82) over 90% of whom live within 5 km of a health care facility (83). Some inequalities in the distribution of health care facilities among rural and urban areas do exist and this limits patient access to quality health care especially in rural areas (84). According to a service availability survey conducted between 2005 and 2006 in most of the districts of Tanzania, the ratio of health care facilities per 10 000 people between public and private was 1:2, with a higher concentration of private facilities in urban areas (82). Poor utilization of services is a challenge, as only one in four women initiate their first ANC visit during the first trimester of pregnancy and nearly half the pregnant women do not comply with the WHO recommended minimum of 4 focused ANC visits (74). Inconsistent visits (85), and poor adherence to ART during pregnancy and breastfeeding have been associated with poor MTCT outcomes (85, 86). Thus to eliminate MTCT and keep mothers alive, more commitment is required to ensure that pregnant women living with HIV have early access to ART and enough support to migrate successfully into the PMTCT cascade (77).

1.6.2.3 Health workforce

There are 153 registered health-training institutions in Tanzania, more than half of which are owned by the government (87). These include 10 medical universities, which produce about 700 medical doctor graduates, and 70 training institutions, producing 2718 nurses, and midwife graduates per year (87). Despite the fact that the government employs nearly 70% of the graduates, the health sector in the country still faces a critical shortage (56%) of trained health workers and the physician density of 0.4 per 10 000 people (87) is far below the ratio (23 per 10 000) recommended by WHO for offering effective basic health services (88). The shortage is most pronounced in primary health care facilities where most of the PMTCT services are offered (87, 89). The shortage is extended to the health professionals in the health training institutions, where the estimated deficit is nearly one third (87). Contributory factors include inadequate funds for training, and limited numbers of institutions and trainers. As a result, low numbers of health care providers are trained, limiting the pool of health care providers to be recruited and to be allocated to the health care facilities (87). These challenges are further exacerbated by poor retention of staff. In 2013, out of all health care providers employed by the government, only 63% reported for work and of these 13% left for various reasons (87). Staff retention is even worse in rural areas where the working conditions are poor, for instance there is no comfortable staff housing available, the roads are poorly maintained and essential social services are limited (90).

1.6.2.4 Health Information System

Before 2013, the Ministry of Health in Tanzania was using a health management information system that required each health care facility to summarize data manually and send it to the district for compilation of district statistics. From the district level, data was then sent manually or electronically to the regional level and subsequently to the national level (87). This system was associated with challenges related to poor data completeness, consistency and linkage, especially linkage of mother-infant pairs in PMTCT. The system has now been replaced by the District health information Software 2, which includes an open-source health management data platform and is currently being implemented in 47 countries in the world (91). The software uses mobile phones to send data from the health care facility directly to a central database. As part of the upgrade, computers have been procured and installed in all districts and health care facilities in the country and data collection and reporting tools are in place at all health care facilities and district offices (87).

1.6.2.5 Access to essential medicine and medical supplies

Medicines and medical supplies in Tanzania are provided through the public non-for-profit system (56%), while the remaining proportion is through the private-for-profit sector (82). The medical store department (MSD) is responsible for ordering and distributing all the medical supplies used in public health care facilities (92). Private health care facilities procure medical supplies from MSD and also from other sources such as private

pharmacies. MSD's procurement process can take about three months for purchases from local suppliers and six to nine months for international procurement (93).

The major concern is stock-outs of medicines and other commodities, especially in rural public primary health care facilities (82). Threats to the quality of PMTCT care, such as stock out of HIV test kits, ART and infection prevention supplies, have been reported in ANC/PMTCT facilities in Tanzania (94). Apart from limited funds with which to purchase adequate medical supplies, the weakness in supply chain management at health care facility level (poor forecasting) and central level (inadequate filling and delivering orders) is an additional challenge (95). To minimize the problem MSD has changed its procurement modality and from 2017 medicines and medical supplies are procured directly from manufacturers instead of suppliers (92).

1.6.2.6 Health care financing

Tanzania relies on a mix of financing sources such as taxation (26%), donor funding (40%), out-of-pocket payments (32%), and prepayment schemes (2%) to support its health care system (96). The domestic share contribution to the health budget in 2015/16 was estimated at 82% and health expenditure as a percentage of total government expenditure was 11.3 % (97). This is less than the recommendation in the Abuja Declaration that countries should spend 15% of the annual government budget on improvement of the health sector. The commitment was signed in April 2001 by African union countries, including Tanzania (98). Total expenditure on health as a proportion of GDP in 2014 was 5.6 %, which is less than in Uganda (7.2%) and in Rwanda (7.5%) (99). Given the insufficient contribution from the domestic funds, the national HIV programme including PMTCT care is largely donor-dependent and the PEPFAR supports 98.8% of the costs for ART (19).

1.6.2.7 Leadership/Governance

The President's Office Regional Administration runs the primary health care facilities through the local government authorities (which are responsible for implementation of health services) within the districts. District councils take full responsibility for executive tasks in health and social welfare. Regional Health Management Teams provide technical support to all public and private health service providers to improve the quality of the Council health services, without taking over operational responsibilities (93). The Ministry of Health, Community Development, Gender, Elderly and Children has regulatory power over all health care facilities. The Ministry is responsible for the formulation of health policy, goals and guidelines as well as guiding their implementation (93). All public and private health care facilities in the country are guided by the national health policy; in addition, the Private Practitioners Act regulates private practice. Despite this well-established leadership system, the accountability, health information reporting, and feedback at primary health care level is limited by the inadequate capacity of leaders to perform their work (93).

1.6.3 Improving effectiveness in PMTCT implementation

With the availability of the regimen with proven efficacy for PMTCT, efficient PMTCT service delivery that meets a minimum standard for quality care is essential for achieving EMTCT targets. WHO recommends Option B+ for PMTCT as it has proved to be effective in EMTCT and a cost-effective intervention. Apart from being effective in PMTCT, with benefits also extended to future pregnancies, the option is effective in preventing infections to partners and improving maternal health (77). Nevertheless, in the review of modelled cost-effectiveness studies, Option B/B+ was found to be more cost-effective than the previous options in the prevention of infections to the partner and infant and to have potential for reducing future treatment costs (100). However, the success and benefits of this intervention are dependent on effective implementation, which can be hampered by the health system factors (46).

It is important to note that pregnant and breastfeeding women may not be utilizing PMTCT services efficiently also because of social or behavioural problems, such as HIV-related stigma, lack of partner support or negative attitudes toward health care providers (78). There is some evidence that social intervention to support these mothers, such as the involvement of male partners, peer mentors and CHWs, can improve the uptake of ART, retention in PMTCT services, and the uptake of early infant HIV testing (101). Similarly, behavioural intervention, such as the use of mobile phone-based reminders, has also shown some positive effect in these areas (101). While structural interventions, such as conditional cash transfer, training of midwives, integration of PMTCT services and enhanced referral, have some positive effect on the uptake of ART and infant HIV testing but not on retention in PMTCT care (101).

The available results of the economic evaluation of such interventions show that involvement of male partner was cost-effective in increasing HIV-testing among pregnant women as well as averting MTCT (102). Furthermore, the integration of PMTCT services in routine maternal and child health services was cost-effective in increasing PMTCT uptake and averting MTCT (103).

The question is how we motivate these pregnant women living with HIV to utilize the available services in order to receive these benefits, while remembering that these women present to the PMTCT health care facilities with various needs. These women expect high quality health services, physical comfort and emotional support (104), and if their expectations are not adequately met, they lose confidence in the health system (105). Patient satisfaction with the health services is an output of a well-functioning health system (80).

Health care providers' interpersonal quality care is a service delivery indicator with a strong influence on patient satisfaction (106). Thus, patient-provider interaction, characterized by good communication and patient-centred care, is necessary for a positive influence on patient satisfaction and retention in HIV care (104). Furthermore, patients are dissatisfied with health services provision in health care facilities where health care providers are

dissatisfied or burned out (107). While the providers are expected to deliver services that meet the clients' needs, their own needs are sometimes not being met and, as a consequence, they can also become dissatisfied (108). For instance, their motivation may be limited by poor working conditions, low remuneration, work-related stress, and unclear description of roles and responsibilities as well as limited organizational and professional commitment (108).

WHO recognizes task-shifting, also referred to as task-sharing, as the rational redistribution of tasks among the available health care providers. Thus, based on a major global shortage of health care workers, WHO recommends task-shifting as a part of the solution for achieving universal access to HIV/AIDS services (109). Task-shifting is defined by WHO as a process of delegation whereby tasks are moved, where appropriate, to less specialized health care providers (109). Task-shifting is not a new concept; it has also been practised in the form of moving some tasks with appropriate supervision, from highly qualified health care providers to less well-qualified health care providers (110, 111). When properly executed, the task-shifting model can result in a more efficient use of the available workforce without compromising the quality of care (112).

As a response to the HIV epidemic, the task-shifting model has also used CHWs and lay counsellors to improve health systems efficiency for implementation and scale-up of various interventions in low-and middle-income countries (113). In March 2016, the government of Tanzania signed a task-sharing policy, which will allow trained CHWs to perform rapid HIV testing (19). A task-shifting model using CHW was found to reduce workload of the health care providers, improve quality of service delivery and also improve patient satisfaction with services (114). Hence, CHWs are key partners in service delivery, although they face challenges including a lack of recognition, low or no remuneration and little involvement in decision-making (115). Furthermore, based on their capacity to link community and health care facilities, CHWs can promote the uptake of voluntary HIV testing, PMTCT counselling, adherence counselling and home-based care support to people living with HIV (112). Previous studies have shown that, task-shifting can result in substantial cost-saving and clinician's time saving without compromising the quality of care (116).

Thus, in countries where there is a critical workforce shortage like Tanzania, increasing the number of health care providers rapidly to meet the demands of PMTCT care may not be feasible, due to the challenges related to training, recruitment, and allocation, exacerbated by poor retention, task-shifting can be used as a short term solution. However, WHO advises that long-term efforts to train, recruit and retain more qualified health care providers should not be replaced by the use of CHWs. In addition, the health system should ensure that CHWs receive appropriate training, formal recognition and remuneration (109).

2 THE RATIONALE FOR THIS THESIS

MTCT continues to be a significant problem especially in sub-Saharan Africa and is denying children the opportunity of HIV-free survival. Tanzania is among the 22 countries with the highest number of pregnant women living with HIV, and as such is a targeted country for EMTCT. The country has made significant progress in cutting down the number of new HIV cases among children but still, the MTCT rate is 8% and there are 10 000 new infections among Tanzanian children annually (11). This is a cause for concern because clinical trials conducted in the country have shown promising results regarding the feasibility of reducing MTCT to rates of less than 5%, which is the EMTCT target (117).

With the introduction of PMTCT Option B+ (77), global and national policy on PMTCT aimed to go beyond the obvious focus of keeping infants free of HIV infection, by also focussing on the health of the mother in the long-term (44). Previous PMTCT strategies (61) mainly focused on preventing MTCT by using ART throughout the breastfeeding period. With the current strategies, all pregnant women living with HIV are supposed to be initiated on ART for life regardless of their CD4 cell count, to keep them alive (14, 77). The purpose is to facilitate the process for health care providers who previously had to choose between various PMTCT options, to make sure women stay on ART throughout the breastfeeding period. By keeping the woman on ART, any future children would automatically be protected against HIV transmission, and secondary transmission to sexual partners would also be strongly reduced (TasP) (77)

For Tanzania to achieve the EMTCT, the identification of the implementation gaps that limit effective PMTCT is crucial. Unlike in clinical trials, resource-limited health systems with shortcomings in relation to governance, financing, human resources, medicines and technologies as well as health information systems will impact policy implementation and service delivery (80). In addition, user barriers (social, economic, cultural and knowledge gaps) are major challenges to the uptake of services and retention in care in real-life settings (46, 94, 118). When it comes to HIV care, the stigma attached to this infection and the real risk of discrimination and social exclusion that many women living with HIV face makes PMTCT uptake and retention particularly complicated, requiring insightful and contextually adapted solutions.

This thesis focuses on three of the health system building blocks, including health service delivery, health workforce and financing, and studies the possible barriers to accessing PMTCT services in Dar es Salaam, Tanzania, when the country was switching to PMTCT Option B+. The first paper of this thesis (Paper I) examined whether patients were satisfied with the PMTCT services they received and which factors led to dissatisfaction, given that dissatisfied patients are thought to adhere more poorly to health services. The second paper (Paper II) examined the other side of the coin, i.e. the satisfaction of health care providers working with PMTCT, assuming that a dissatisfied health care provider is less likely to provide good services. The third paper (Paper III) identified PMTCT tasks that could be task-shifted from trained health care providers (primarily nurses), who are in short demand, to

lower-qualified staff cadres, such as CHWs, to alleviate some of the problems and improve efficiency. Finally, the last paper (Paper IV) looked at the effect of early enrolment and adherence to ANC/PMTCT care, including the minimum number of 4 ANC visits recommended by WHO in 2001, on possible future cost savings resulting from averting MTCT.

3 OBJECTIVES

3.1 GENERAL OBJECTIVE

To assess patient and provider satisfaction, potential for task-shifting and cost-effectiveness aspects of uptake and adherence to the PMTCT programme in terms of preventing MTCT of HIV in Dar es Salaam, Tanzania.

3.2 SPECIFIC OBJECTIVES

1. To assess patient satisfaction and factors related to dissatisfaction with PMTCT care in public health care facilities in Dar es Salaam, Tanzania (Paper I)
2. To assess the level of job satisfaction and intention to leave the current job among health care providers in public health care facilities offering PMTCT/ANC services in Dar es Salaam, Tanzania (Paper II)
3. To measure the average time nurses spend on delivering the different PMTCT tasks and to estimate potential savings in terms of cost and workload that could be achieved by shifting some tasks to lower cadre staff (community health workers) in health care facilities providing PMTCT services in Dar es Salaam, Tanzania. (Paper III)
4. To evaluate the cost-effectiveness of adherence to the recommended minimum of 4 ANC visits on MTCT among pregnant women living with HIV under PMTCT Option B+ in Dar es Salaam, Tanzania. (Paper IV)

4 MATERIAL AND METHODS

4.1 GENERAL SUMMARY OF MATERIAL AND METHODS

Table 3: Summary of methods in the papers included in the thesis

Papers	Study design	Data collection Study Population	Main outcome	Main analysis
I	Quantitative cross sectional survey	Structured interviews 600 pregnant and breastfeeding women living with HIV, receiving PMTCT care in public health care facilities in Dar es Salaam, between March and April 2014.	Patient dissatisfaction with PMTCT services	Descriptive statistics and multivariate logistic regression analysis
II	Quantitative cross sectional survey	Structured interviews 250 Health care providers providing PMTCT care in public health care facilities in Dar es Salaam between March and April 2014.	Provider job satisfaction and turnover intention in PMTCT clinics	Descriptive statistics and multivariate logistic regression analysis
III	Time and motion study	Direct observation and Mapping of task to potential skill abilities of CHW 179 Patient-provider interactions in public health care facilities in Dar es Salaam observed between March and April 2014.	Time spent in each PMTCT activity. Time and cost that could be saved by task-shifting	Descriptive statistics
IV	Cost-effectiveness analysis	Micro-costing and secondary analysis of de-identified, routinely collected health system data 2436 women newly diagnosed to be living with HIV, who delivered between August 2014 and May 2016 in Dar es Salaam	Incremental cost per MTCT averted for making at least 4 ANC visits	Descriptive statistics and cost-effectiveness analysis

4.2 STUDY SETTING

All four studies were done within health care facilities providing PMTCT services in Dar es Salaam, Tanzania. Dar es Salaam is the largest commercial city and one of the 31 administrative regions in the country. During the study period, the region consisted of three administrative districts named Kinondoni, Ilala and Temeke (**Figure 4**), although two new districts, Ubungo and Kigamboni, have been recently established making a total of five districts (119). As of the official census conducted (every 10 years) in 2012, there were 4 364 541 people living in the Dar es Salaam region (16). Almost two thirds of Dar es Salaam residents live in informal, unplanned settlements with limited infrastructure (16).

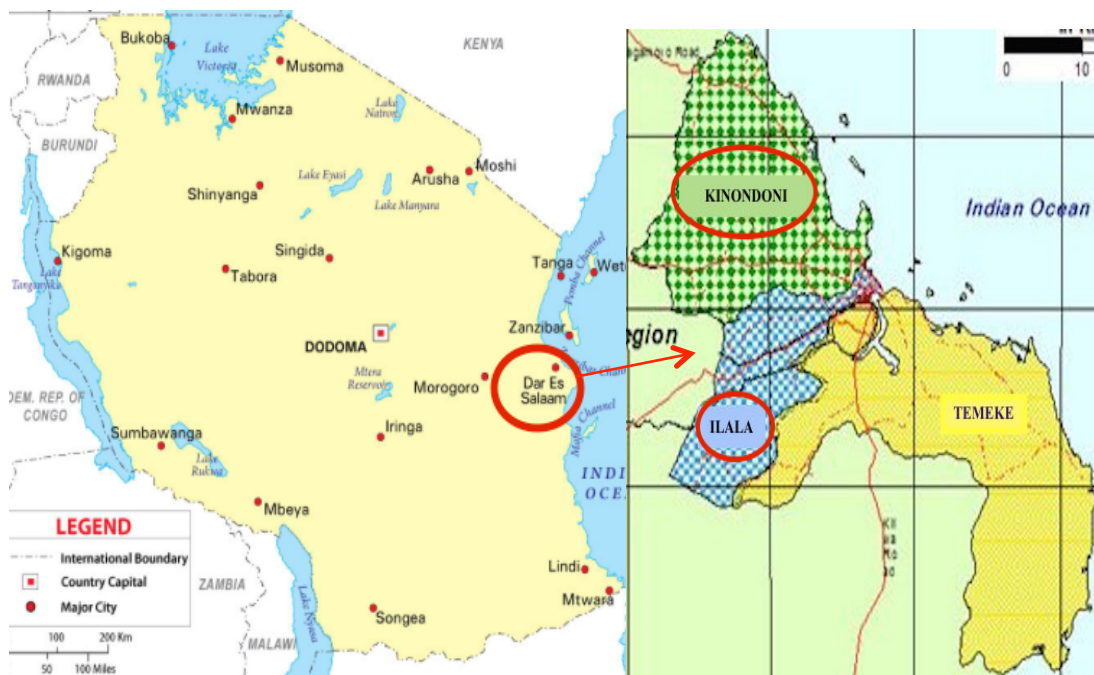


Figure 4. Map showing location of Tanzania and the three original districts of Dar es Salaam.

Adapted from major cities of Tanzania. Retrieved from <https://www.mapsofworld.com/tanzania/cities/>
Copyright 2012-2013 by mapsofworld.com. & Administrative map <http://cammi.de/images/DaresSalaam-cityadminmaps-small.jpg> Copyright 2006 by Erika Cammi.

Health care facilities in the country (120) are more concentrated in Dar es Salaam (8% of dispensaries, 7% of health centres and 15% of hospitals). Furthermore, doctor density is almost six times higher in the region than the national average, and there are almost 1.3 nurses and 2.6 nurse midwives per 10 000 population, compared to the national average of 2.6 medical doctors and 3.2 nurses and midwives combined per 10 000 population (87). Dar

es Salaam has a total of 213 reproductive and child health facilities that provide PMTCT services. Of these, 185 facilities are supported by the Management and Development for Health (MDH), a PEPFAR-funded program, which provides technical support for HIV care and treatment in all public and some private facilities in Dar es Salaam (121). The health care facilities (private and public) in Tanzania offer services according to the national PMTCT guidelines (73) adapted from the WHO guidelines, which also describe important activities that should be carried out during each clinic visit.

Studies I, II and III were done in the Ilala and Kinondoni districts in Dar es Salaam and study 4 involved all three original Dar es Salaam districts (**Figure 4**).

4.3 SAMPLING AND DATA COLLECTION (PAPERS I, II & III)

4.3.1 Health care facility sampling

The initial plan envisioned nesting the thesis studies within a large cluster-randomized trial, which aimed to evaluate the implementation of potential interventions for achieving universal access to PMTCT services to reduce transmission of HIV (122). During this time, option A was used as a standard of care for PMTCT in Tanzania. The trial used a two-by-two factorial design where women were first randomly allocated to receive the CHW intervention or not, and then to receive either PMTCT Option B or A. The trial was planned to be conducted and had already started in public health facilities in two of the three Dar es Salaam districts, because another intervention supported by the UNICEF was taking place in Temeke district. However, following the rapid policy change mandating the country to implement Option B+ instead of option A, the trial was stopped prematurely. Thus the thesis studies were modified and conducted as stand-alone studies, which were conducted in the initially selected districts that together are home to 70% of Dar es Salaam residents (16).

For Papers I, II and III, we conducted studies in health care facilities providing PMTCT services in Ilala and Kinondoni. In total, there were 150 ANC/PMTCT facilities in these two districts (49 in Ilala and 101 in Kinondoni), which included 92 non-public facilities (**Figure 5**). Public health care facilities were used because they are more affordable to the majority of the population in need of basic health services and represent the real-life situation of health care facilities in Tanzania (83).

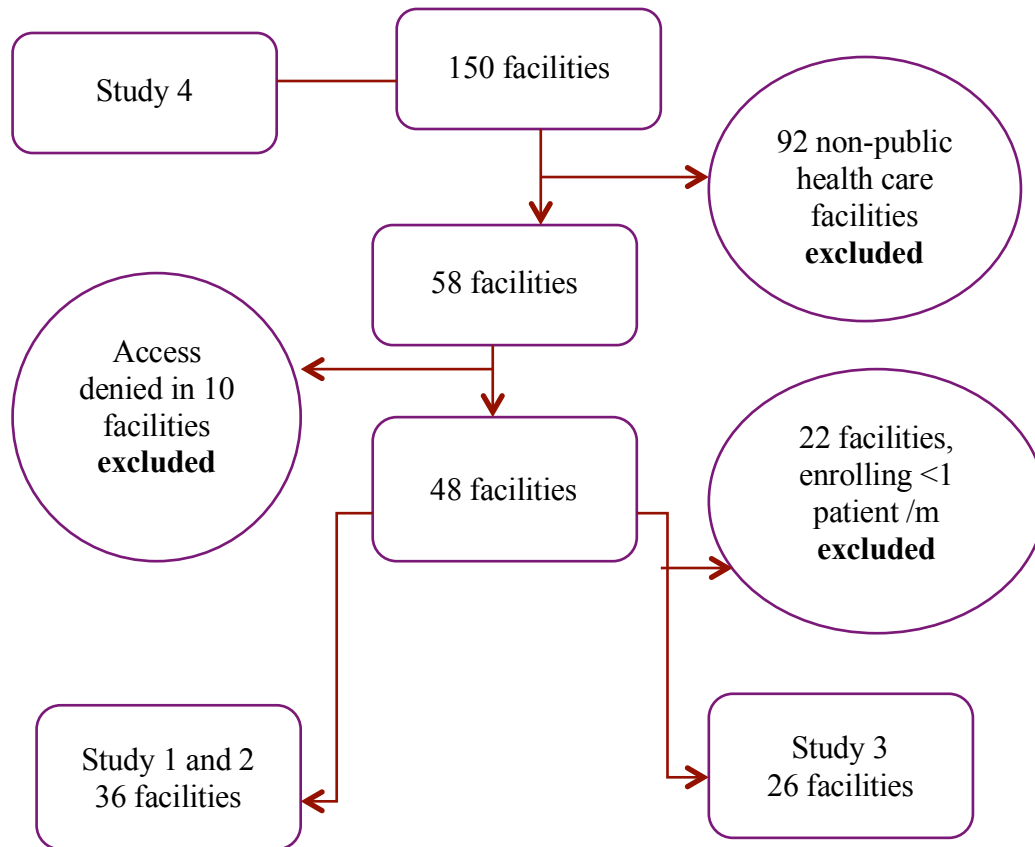


Figure 5. Flow diagram of health care facility sampling, study 1, 2, 3 and 4

4.3.2 Study participant sampling and recruitment

Paper I: Based on the length of the questionnaire, we estimated that one interviewer could efficiently complete at least three interviews per day. Thus, at the health care facility level, each day the interviewers listed the names of the pregnant and breastfeeding women seeking PMTCT services. From the list, a simple random sampling was used to select three patients, then written consent was requested before inviting them to participate in an interview. The interviews were conducted when the women were exiting the clinics after receiving PMTCT services. If there were no patients registered for PMTCT services on a particular day, the interviewer returned to the health care facility at least twice before removing the facility from the list.

Paper II: All health care providers offering PMTCT services in the selected facilities were invited to participate in the study, 217 (87%) gave consent and were recruited.

Paper III: We randomly sampled working days from the calendar on which to visit each of the selected facilities. On each of the sampled health care facility days, the observer visited the facilities and randomly selected nurse-patient interactions for the time and motion observation.

4.3.3 Data collection Papers I, II and III

Research assistants with a medical background were trained on the data collection tools. For Papers I, and II we used structured questionnaires conducted using the local language (Kiswahili). The survey questions were in a Likert scale form (123). These questions are appropriate for measuring a respondent's opinion or attitude towards a given subject, thus capturing the intensity of the respondent's feelings for a given item. The Likert scales allow respondents to indicate their degree of preferences or opinion including a neutral option without restricting them to a simple YES/NO answer.

The research assistants administered the patient questionnaire (Paper I) face-to-face by and captured overall patient satisfaction, and satisfaction in relation to health system responsiveness (Appendix I). The provider questionnaire (Paper II) was a self-administered survey distributed by the research assistants and captured the health care provider satisfaction with the different aspects of the job and also turnover intentions (Appendix II). To ensure that patients interpreted the questions similarly (Paper I), important concepts such as the meaning of good communication, confidentiality and prompt attention were first defined in the questionnaire. A small compensation was given in Tanzanian shillings equivalent to US\$ 3.1 and US\$ 5 to patients and health care providers respectively for the extra time spent in the clinic to complete the surveys.

For Paper III, four trained research assistant with a medical background observed in real time the routine activities performed by the nurse and recorded the time spent on various PMTCT-related activities. The time of each activity was measured in minutes using a stopwatch and then recorded on a time sheet prepared by the research team. To minimize a potential Hawthorne effect, health care providers were informed that the study aim was purely to estimate the time routinely spent on PMTCT activities for scientific purposes and not for work performance evaluation.

4.4 SAMPLING AND DATA COLLECTION (PAPER IV)

4.4.1 Patient outcomes

The primary patient outcome used as a measure of effectiveness was MTCT within the first 6-12 weeks of an infant's life in relation to the number of ANC visits. We used the de-identified patient level data extracted from the national care and treatment programme's electronic database. The database collects information from all patients enrolled in care and treatment clinics (CTC) and is referred to as CTC2. The CTC2 database is used by more than 300 care and treatment clinics throughout the country to manage data on patients enrolled in CTCs. The database is based on the national HIV care and treatment monitoring and evaluation tools (124). The implementing partners, in collaboration with regional coordinators in each region, export the cleaned de-identified files from health care facility-level electronic databases to the national database. MDH, as the implementing partner for the

Dar es Salaam region, provides technical support for this task and has permission to use the region's de-identified data for evaluating the performance of the programme. We accessed the Dar es Salaam partially cleaned CTC-2 database through MDH containing the de-identified routinely collected health system data in various datasets.

We extracted, cleaned and linked the datasets relevant for this analysis including pregnancy, HIV-exposed infants (HEI), visits and medication datasets. We linked the mother datasets using the mother's unique identification number (CTC-2 ID), and then we linked the infant's dataset to the mother's dataset using the unique infant identification number present in both databases. From the linked mother-infant database, we extracted information regarding the infant's date of birth; date of the infant HIV test (DNA-PCR) the date of the HIV test results and the date of each clinic visit. We also extracted information related to the mother's demographic characteristics, CD4 cell count, WHO disease stage, self-reported ART adherence (patients self-report they have been taking "all" ART tablets as prescribed in the previous visit) and infant feeding option choices.

We identified a total of 4450 mothers who delivered between August 2014 and May 2016. As we were interested in studying the newly diagnosed pregnant women living with HIV, we excluded 2014 pregnant women already on ART. From the remaining 2436 newly diagnosed pregnant women living with HIV, a total of 100 mother-infant pairs with no information regarding the infant's date of birth or the mother's expected delivery date were excluded. Furthermore, an additional 27 mother-infant pairs were excluded because infants had a first DNA PCR test after 12 weeks post-delivery. The remaining sample of 2309 mother infant pairs was analyzed.

4.4.2 Costing and unit costs

We estimated costs from the service provider's perspective using a micro-costing approach which involves the direct enumeration and costing out of inputs consumed in the treatment of a particular patient (125). The provider unit cost contribution for each integrated ANC/PMTCT service was calculated from the unit time and cost of a health care provider per patient visit observed in Paper III. The cost for tracking patients, who missed a clinic visit, was obtained from cost estimates documented in other empirical studies involving adults living with HIV in Dar es Salaam, Tanzania (126, 127).

Medication costs included both the price of the antiretroviral medications and the cost of health care provider time spent in dispensing the ART. The price of ART were based on the market price as reported in the 2013 WHO Global Price Reporting Mechanism (GPRM)(128) and the 2016 Clinton Health Access Initiative (CHAI) reference price list (129). The actual cost of performing laboratory tests was obtained from another empirical study conducted in HIV clinics in Dar es Salaam (126). All costs and effects incorporated into the cost-effectiveness analysis occurred within the one-year time horizon, thus no discounting was done.

4.5 DATA ANALYSIS

Statistical analyses for all four papers were performed using Stata software version 14 (Stata Corp 2014 Stata Statistical Software).

4.5.1 Statistical analysis Paper I

We first examined the distribution of the Likert scale patient responses using histograms and frequency tables, and then we dichotomized the variables for overall patient response and the patient-provider interaction to binary outcomes. The responses including “neutral”, “fair” and “poor” were labelled as “dissatisfied”, while “very good” and “good” were labelled as “satisfied”, the outcome of interest was being “dissatisfied” with the PMTCT services. We also dichotomized the responses for the independent variable; the responses including “neutral”, “fair”, and “poor” were labelled as “poor”, whereas the responses including “very good” and “good” were labelled as “good”. The responses for the independent variables that were in a 3-item scale were categorized as “YES” if responses were “most of the time” or “sometimes”, and “NO” if the response was “no”.

Using frequencies and Fisher’s exact test, we explored the association between the outcome “dissatisfaction with PMTCT services” and independent variables; both univariate and multivariate logistic regression analysis were used to investigate factors associated with patients being dissatisfied with PMTCT services. A stepwise logistic regression analysis was done, by including variables from the univariate analysis with p-value <0.2 in the model. Then we removed items with the highest p-value one at a time and re-fitted the model until all variables remaining in the final model had a p-value of <0.05. Taking into account the possible multiplicative interaction between the variables, we added their product terms in the model and a formal p-value for departure from interaction was obtained using a likelihood ratio test comparing the maximized log-likelihoods of the model with and without the product terms. In the final logistic regression model, we examined the variation of the probability of overall dissatisfaction with PMTCT services in relation to possible predictors and reported the results as odds ratios (ORs) and 95% confidence intervals (CI). The total visit time, the only continuous predictor that was significant, was modelled assuming linearity, and we used the restricted cubic splines with three knots (130) at fixed percentile of its distribution to examine potential departure from linearity.

4.5.2 Statistical analysis Paper II

For this Paper, we first assessed the internal consistency of the job satisfaction scale containing 42 questions with a 5-item Likert-scale organized in 9 domains related to various aspects of the health care provider’s job. These domains included remuneration, equipment and work context, workload, duties, harmony in the workplace, training, management, moral satisfaction and job stability (being able to keep the same job for a long time). The Cronbach alpha coefficients showed a fair reliability (0.69) for the job stability domain and good reliability (0.77 to 0.92) for the remaining 8 domains.

Similar to Paper I, we converted 5-item (job satisfaction) and 7-item Likert scale (turnover intention) responses to a binary outcome. For the 5-item Likert-scale, the responses including “neutral”, “dissatisfied” and “very dissatisfied”, were labelled as “dissatisfied” with current job, while the responses including “very satisfied” and “satisfied” were labelled as “satisfied” with current job. For the 7-item Likert-scale, the responses including “very often”, “fairly often”, “often”, “occasionally”, “rarely” and “almost never” were interpreted as having an intention to leave, while those who reported “never” were considered to have no intention to leave their current job.

For this Paper, the independent variables included in the model consisted of the characteristics of: the health care provider such as age, gender, education level, professional cadre and the time in current position; the nine domains summarizing various aspects of the provider’s job; and perceptions of the health care provider regarding Option B+ such as, if it will be the best option to implement, will it be preferred by women or will it be the best option for mothers and their babies. We summarized the data using proportions, and Fisher’s exact test was also used to test for association between the dependent variable (overall job satisfaction or turnover intentions) and the independent variables.

To identify the predictors of overall job satisfaction among the various aspects of the health care provider’s job, separate multiple logistic regression models were created for each of the 9 domains. Variables with the lowest p- values were selected from each model if the p-value was less than 0.2 and these were used to create new multiple logistic regression models. A backward elimination method was used to remove items with the highest p-value one at a time until the remaining items had a p-value <0.05. The model was adjusted for the health care provider’s opinions regarding the women’s preference for Option B+ because it had a positive significant association with overall job satisfaction. The final model was further adjusted for age, education level, level of health care facility and professional cadre, as well as for clustering of standard errors at the health care facility level. Similar procedures were followed to identify the predictors of the turnover intention. The interaction between significant predictors in the job satisfaction and turnover intention model was examined by adding their product terms in the respective final multiple logistic regression models and a formal p-value for departure from interaction was obtained using a likelihood ratio test comparing the Maximized log-likelihoods of the model with and without the product terms. The results are presented as Odds ratio (OR) and their 95% CI.

4.5.3 Statistical analysis Paper III

The characteristics of health care providers (nurses) were summarized as proportions and the time spent on each activity was summarized as mean and 95% CI.

4.5.3.1 Identifying tasks that can be task-shifted

Based on the WHO Global Recommendations, some of the PMTCT tasks such as HIV counselling and testing, HIV test interpretation, and patient follow-up and providing

adherence support can be performed by the CHW (109). Thus, we mapped the tasks recommended in the WHO task-shifting guideline against the tasks observed during the different types of PMTCT visits.

4.5.3.2 Estimating the cost for activities as observed

Estimation of the cost for the activities performed was based on the monthly government salary of nurses who are the main providers of the PMTCT service. During the study period, a nurse officer earned a salary equivalent to US\$ 495/month and enrolled nurses and nurse midwives earned a salary equivalent to US\$ 438/month. The weighted average salaries were calculated because different nurse cadres were observed to contribute different proportions of these visit times. The cost for each task was calculated by applying the unit cost to the time spent to complete a particular task during a specific visit

4.5.3.3 Estimating the cost for activities as if they were task-shifted

We calculated the total time of activities that could be task-shifted to CHWs and we applied various salary estimates for CHW. Since there was no established salary scale for this cadre in the country, we made assumptions for the level of the salary they could be paid. One assumption was based on the minimum salary (US\$ 172 per month) for a formally trained Tanzanian health care provider equivalent to a CHW level in the public-sector health system (131). A second assumption was based on the remunerations (US\$ 30 per month) paid to lay health workers in an empirical study in Tanzania (122, 127), and finally we used the upper bound of the remuneration range for CHWs in Tanzania (US\$ 150), which was recommended in another study based on a normative analysis (132). The cost for each task that could be task-shifted was calculated by applying the unit cost to the time spent to complete a potentially task-shifted task during a specific visit. Here we assumed that a CHW would spend almost the same amount of time to complete a task-shifted task as the current health care provider.

4.5.3.4 Estimating the potential cost savings

The monthly salary estimates for nurses and CHW were converted to minute salary estimates, based on 22 working days per month and 8 working hours per day. All costs were converted from Tanzanian shillings (TZS) to US dollars (US\$), using the average exchange rate for the month of December 2015 (1 USD = 2154 TZS).

To calculate the cost after task-shifting, we applied the per-minute cost estimate for CHW salary on a task that could be task-shifted and the weighted nurse's salary to the activities that cannot be task-shifted. Finally, the potential cost savings due to shifting of tasks to CHWs was estimated as a difference between the cost before and cost after task-shifting.

4.5.4 Statistical analysis Paper IV

For this analysis, we first described baseline characteristics of the study patients in relation to the MTCT outcomes and the number of clinic visits attended (≥ 4 visits vs < 4 visits). The

resource used per patient, as estimated from the patient level data, was multiplied by the unit cost to obtain the cost per patient associated with PMTCT service utilization. The health outcome measure of effectiveness was the MTCT averted when women made at least 4 ANC/PMTCT clinic visits.

We used the Pearson chi-square test to test for difference in MTCT averted between pregnant women who made at least 4 clinic visits and those who made fewer than 4 clinic visits before delivery. The cost data were summarized in a Microsoft Excel 2010 spread sheet; this included the cost of the services utilized by the patient during their clinic visits, including cost for health care provider's time, laboratory tests and ART.

Cost-effectiveness was estimated as the incremental cost-effectiveness ratio (ICER) representing a gain in terms of the cost per MTCT case averted, defined as:

$$\text{ICER} = \frac{(\text{Cost} \geq 4 \text{ visits}) - (\text{Cost} < 4 \text{ visits})}{(\text{MTCT averted} \geq 4 \text{ visits}) - (\text{MTCT averted} < 4 \text{ visits})}$$

To evaluate the effect of uncertainty related to the ART price estimates and cost of tracking PMTCT defaulters on ICER, we used a multi-way sensitivity analysis. To account for the uncertainty of these parameters, we changed simultaneously the value of each parameter over the upper and lower ranges of the reported estimates.

4.6 METHODOLOGICAL CONSIDERATIONS

Paper I and II used a structured questionnaire including Likert scale items. Thus it was an appropriate way to capture the opinions of patients regarding satisfaction with their care (Paper I) and of health care providers regarding satisfaction with their job and also with regard to intentions of leaving their job (Paper II). The problem with these types of questions is that respondents may avoid extreme responses for fear of negative implications. Research assistants with medical background were trained on the importance of confidentiality and anonymity and had no role in the care of the interviewed patients or supervision of the health care providers. However, there is still a potential risk that patients did not dare to be too negative about the studied PMTCT services (Paper I). This type of information bias is however highly unlikely for the data derived from the health care provider surveys (Paper II) which were self-administered and anonymous.

Paper III, used a time and motion approach, a scientific method for recording time spent on a variety of tasks. The use of direct observation rather than self-reporting removed bias associated with over-reporting of the task times. The mapping of the task according to the WHO recommendation was useful for identifying which routine PMTCT tasks could be done by CHWs. Furthermore, the cost estimates were based on the plausible assumptions based on

the empirical evidence. A possible limitation is the assumption that CHWs would need the same amount of time as existing trained and experienced nurses to deliver a particular PMTCT service. This assumption is possibly biased because we did not observe the time taken by CHWs to complete tasks, however, with time and repetition of tasks, this can be achieved, as health cadres with comparatively short training have been observed as being very efficient at executing new complex tasks (133, 134). Neither did we estimate the cost of training the CHW to perform the tasks, which were to be delegated to them, thus our estimates of the cost saving could have been underestimated or overestimated.

For Papers I, II and III, we used only public facilities and this may limit the generalizability of the findings to other non-public facilities in Dar es Salaam and the rest of the country. A patient or health care provider in non-public facilities could be more satisfied or dissatisfied as compared to those in public facilities. This is because, despite the high workload and low salaries, a health care provider prefers employment in public facilities because of the favourable pension scheme not offered in the private facilities (135). On the other hand, they may prefer a better working environment and remuneration benefits, which are limited in public health care facilities. However, despite the attractive remuneration, health care providers in the private health care facilities could be dissatisfied because of facing the pressure of increased accountability (136). Furthermore the time taken to complete the task could be different and because of relatively higher salaries, the unit cost may be higher than our estimates. Thus, since the public health care facilities represent a real life situation of a health care facility in Tanzania, where the majority can afford the health services and health care providers prefer the long-term benefits, our results are useful in this context.

Paper IV is based on the economic evaluation comparing the number of ANC visits (<4 vs at least 4) in relation to MTCT. One of the strengths of this study is that it provides empirical estimates from real-life data and there was no form of enhanced compliance with the visits. The MTCT outcomes were estimated from a large number of routine records of patients in the same region where the time motion study, which estimated the unit time for PMTCT tasks, used to estimate the health care provider's time cost was done. Furthermore the patient population we used is representative of all women receiving PMTCT care at all levels of health care facilities in Dar es Salaam.

Our analysis has several limitations; first the ICER is presented as a cost per unit MTCT averted. While this composite clinical end point is useful to estimate disease-specific cost, it is limited in terms of comparing the value for money of our estimates with other interventions and may be less useful to decision makers.

Secondly, the analysis was restricted to the provider's perspective and thus represents a conservative estimate because the total cost of ANC extends beyond health care costs including patient's transport cost and time. The patient's cost could have been significant, but was omitted because this data was not collected, since the provider perspective had been chosen for measuring cost. Finally, this study there is a likelihood of an underestimation of the true MTCT rate in mother-infant pairs with poor adherence to clinic

visits. This is because most women in this setting breastfeed their babies for at least 12 months, and the ART adherence drops significantly with time post-delivery (137).

4.7 ETHICAL CONSIDERATIONS

The ethical permit for Papers I-IV was obtained from the Institutional Review Board (IRB) of the Muhimbili University of Health and Allied Sciences (MUHAS). Informed written consent was obtained from the women living with HIV (Paper I), health care providers (Paper II) and both (Paper III). In paper IV, we used the de-identified data routinely collected, stored in the national database and available for health service evaluations.

Completed questionnaires were stored in a locked metal filing cabinet and a password-protected electronic database only accessible to the research team. To maintain the patient confidentiality we did not use any patient identifying information such as names or clinic registration number. The women (Papers I, II and III) could have been exposed to the risk of being identified and stigmatized because of their HIV status. Thus, we trained the research assistants who because of their medical background were also keen to observe confidentiality. This was important because of patients' fear of disclosure of their HIV status, for fear of subsequent HIV stigma and the risk of loss of economic support, factors that can affect the uptake and retention in PMTCT care (78).

Health care providers could have been worried that the evaluation of their performance related to their responses or time spent on activities could be related to their remunerations or lead to them losing their job. Hence we made the questionnaires and the time motion datasheet anonymous by not including their names or any identifying information. We also explained clearly the purpose of the study and as such assured the health care providers that there was no relationship between our observations and surveys and the regular staff performance evaluations done by the Ministry of Health or local the government in these health care facilities.

4.8 MY ROLE IN STUDIES INCLUDED IN THIS THESIS

I was involved from the initial stages of designing the initially planned cluster randomized trial, where I helped design the training materials, train research assistants and supervise the trial. I then worked with my supervisors to redesign the new thesis studies and we drafted a modified analysis plan. I drafted the initial version of the surveys and requested permission to use and modify the tools developed by other researchers, such as the tool designed in Mali and Senegal and validated for use in African settings. I worked with my supervisors and other co-authors to finalize the surveys, which were used for data collection. I requested ethical clearance for all four papers.

I trained all research assistants and prepared them for data collection and supervised them during data collection, specifically for Paper I and II. I trained them on how to use the questionnaires and we piloted the questionnaires before creating a final version. For Paper III, I trained research assistants on time motion studies before starting data collection. I then mapped the observed tasks according to the WHO guidelines and calculated various estimates reported in the paper. For Paper IV, I requested permission to use the database and I cleaned and linked different datasets and created the final dataset used in the analysis. Under supervision, I conducted all the data analysis for all four papers, drafted the manuscripts and finalized the papers after receiving feedback from co-authors and reviewers.

5 RESULTS AND DISCUSSION

This PhD work is built on four studies that fill knowledge gaps and are important for addressing implementation challenges that limit the effectiveness of PMTCT interventions not only in Tanzania but also in similar settings. The main results will be presented and discussed under the subsections reflecting the title of each specific paper.

5.1 PREDICTORS OF PATIENT DISSATISFACTION WITH SERVICES FOR PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV (PAPER I)

We recruited a total of 595 out of 600 eligible women living with HIV, who were receiving PMTCT services from 36 public health care facilities in Dar es Salaam and who had consented to an interview. The participants were generally happy with the services they received and only 8% (N=48) reported being dissatisfied with the care.

5.1.1 Patient characteristics and overall satisfaction with PMTCT care

The average age of the participants was 30 (± 5.3) years. The majority (70%) had completed basic schooling (7 years) and nearly two thirds were in a formal relationship (married or cohabitating). Regarding HIV status, the majority of these women (81%) had known about their HIV status for at least one year and 86% had disclosed their HIV status to at least one family member. More than two thirds of the women received care in the dispensaries.

Clinic opening hours were convenient to most of the women, and the services provided met the expectations of almost three quarters of them. However, none of these factors had a statistically significant influence on women's dissatisfaction with PMTCT care. The women spent an average of two hours during their last visit to the ANC/PMTCT clinic, and those who reported a longer duration were more likely to report service dissatisfaction.

5.1.2 Patient-provider interaction and patient satisfaction with PMTCT care

The women living with HIV perceived the quality of provider-client interaction as high. This was reflected in their ratings of more than 90% in each of the following characteristics of the health care providers: communication, promptness of attention, confidentiality with patient information, understanding patients' concerns and listening well to the patient. A slightly lower proportion (68%) of patients reported that nurses were good at giving an opportunity for patients to ask questions or giving clear explanations to patient's queries (74%). These findings suggest that these important components of health system responsiveness (138, 139) were adequately fulfilled, and provide a plausible explanation for the observed low rates of dissatisfaction. As expected, a poor rating in any of these factors was significantly associated with dissatisfaction with the services.

5.1.3 Predictors of patient dissatisfaction with PMTCT care

Patient dissatisfaction with PMTCT care was largely predicted by three main factors (**Figure 6**), two of these are related to the quality of patient-provider interaction, and one is related to the time spent at the clinic. Patient dissatisfaction increased nearly six-fold if they felt that health care providers had a poor capacity to understand their concerns (OR 5.7, 95% CI 2.3–14.0) and five-fold (OR 4.9, 95% CI 1.8–13.4) if patients perceived that the communication skills of the health care providers were of low quality. Patient dissatisfaction doubled if the women spent more than two hours of their time in the clinic (OR 2.3; 95% CI 1.1–4.7).

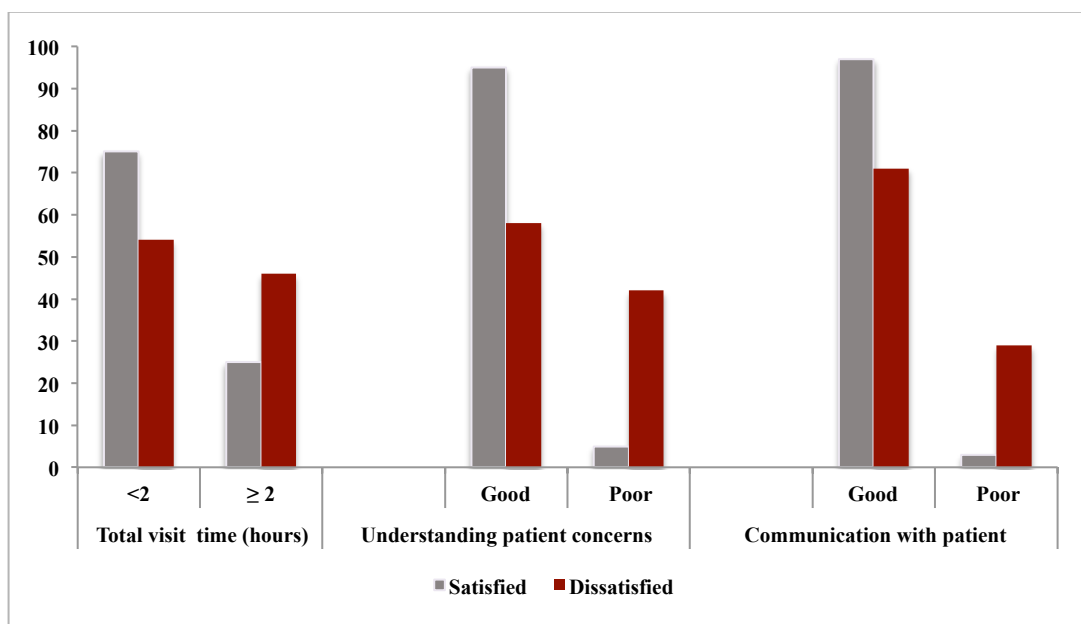


Figure 6. Predictors of patient dissatisfaction with PMTCT services

The estimates show that every 30-minute increment in total visit time was associated with 10% higher odds (95% CI 1.01-1.20) of being overall dissatisfied with PMTCT services (**Figure 7**). Considering all the factors together, the probability of being dissatisfied with PMTCT services was as low as 4% (95% CI 2% - 6%) when all the three factors were favourable and as high as 70% (95% CI 47% - 86%) when all factors were unfavourable. Long visit time and waiting time have been associated with reduced patient satisfaction and shown to affect the utilization of PMTCT services (79, 139, 140).

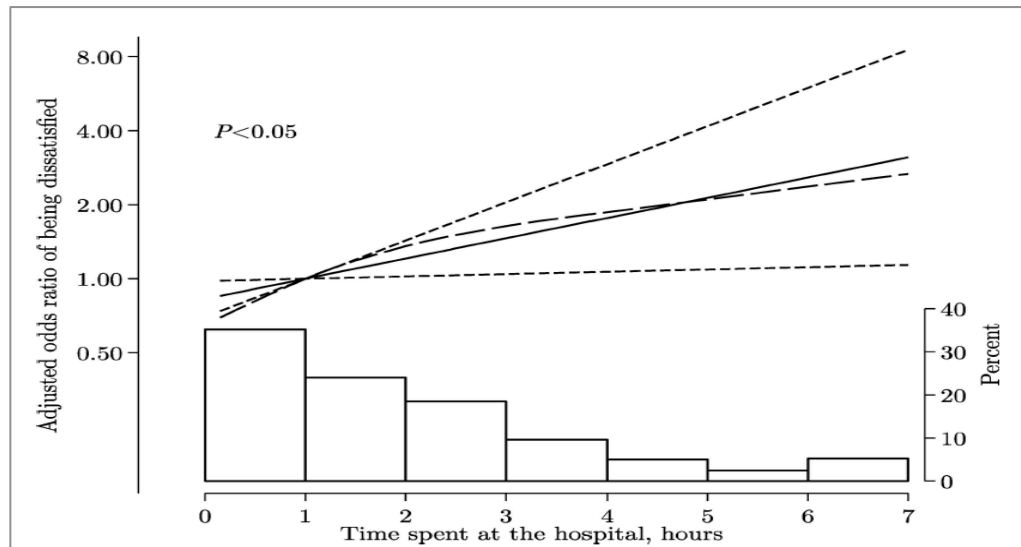


Figure 7. Odds ratio of dissatisfaction with PMTCT services according to time spent at the hospital (hours). Solid line is a linear trend, dashed lines are 95% confidence limits of the linear trend, and the long dashed line is the curvilinear trend estimated with restricted cubic splines.

This study demonstrates that only a few women living with HIV reported dissatisfaction with the PMTCT care they had received. This is possibly because they also perceived the quality of the patient-provider interaction to be good or at least that the services they received met their minimum expectations. The positive influence of a good patient-provider interaction on patient satisfaction has been shown in another study involving people living with HIV (141). This finding has a major implication because patient satisfaction can influence the uptake of, retention in and adherence to ART services (79, 142, 143) and also serves as a determinant of adequate viral suppression (144).

However, the high level of satisfaction we observed does not necessarily mean that the quality of services received by these women was optimal. The women may have feared to criticize the health care services because of the high respect they have for their health care providers and also out of fear of losing out on the future services they are entitled to (145). From our observation, it is evident that patient dissatisfaction can be more evident when the quality of patient-provider interaction is severely compromised, especially in the presence of unacceptably long visit time or if they are not treated with empathy. This highlights specific areas of care, which can be improved to meet the psychosocial and health needs of PMTCT clients.

5.1.4 Implications of the study findings

Improving patient satisfaction has a positive effect on motivating the uptake of and adherence to the PMTCT care including lifelong ART to ensure better MTCT outcomes (104, 105, 144). Thus, our observation suggests that strengthening the service delivery component of the health care system, in the form of achieving high quality patient-provider interaction and short clinic visit time, can contribute to EMTCT. Furthermore, our findings point towards challenges related to the health workforce component, as health care providers may have difficulties in meeting the needs of their patients if their own needs are not met. Thus, the second paper in this thesis aimed to answer the question whether health care providers in these clinics were satisfied with their work.

5.2 JOB SATISFACTION AND TURNOVER INTENTIONS AMONG HEALTH CARE STAFF PROVIDING SERVICES FOR THE PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV (PAPER II)

Among the 213 health care providers who completed the surveys, 54% were unhappy with their current job and slightly over a third of them were thinking of leaving.

5.2.1 Baseline characteristics of health care providers in relation to their job satisfaction and turnover intentions

Most of the health care providers (96%) were female, two thirds had a college education and over half were nurses, including 28% nurse officers and 32% nurse midwives. These health care providers were mostly working in primary health care facilities and they had spent a reasonable amount of time in their current job, only 6% had spent less than a year in it.

5.2.2 Health care providers' satisfaction with different aspects of their job

The satisfaction of health care providers varied in different aspects of their job. While almost all reported to be dissatisfied with the remuneration and workload, they reported to be satisfied with the variety of duties, harmony in the workplace and moral aspects of the work (Figure 8).



Figure 8. Health care provider satisfaction in different domains involving their job: provider responses on a 5-item Likert scale on the questions “how satisfied are you with...”

5.2.3 Factors associated with satisfaction with the current job among PMTCT health care providers

Health care providers who were not satisfied with their salaries were almost six times more likely to be dissatisfied with their current job (OR 5.6, 95% CI 1.2-26.8). This has also been reported in other resource-limited settings, where salaries are generally low (146). In high-income countries, despite the high salaries, satisfaction is essential for influencing the intention of health care providers to stay in their workplace (147). Thus, the high dissatisfaction with salaries has a substantial effect on staff retention in settings where a critical shortage already exists.

We also observed that the limited availability of protective materials such as gloves increased the likelihood of being dissatisfied with the current job four-fold (OR 4.0, 95% CI 1.5-10.6). This has also been observed elsewhere (148), and it is probably because it puts health care providers at risk of contracting infections, especially HIV (149). This underlines the importance of personal safety in the workplace, including adequate protection against infections and injuries.

A poor job description and poor working hours also stood out as other important factors of job dissatisfaction among health care providers, resulting in a four-fold (OR 4.3, 95% CI 1.3-14.7) and three-fold (OR 3.2, 95% CI 1.3-7.6) increase respectively in the odds of being dissatisfied with the current job. It has been shown that, with a high workload and a high number of clients, the few available health care providers are often forced to assume additional responsibilities, with no choice for specific tasks (108, 149). Thus, their dissatisfaction may also be the result of a struggle to cope with competing demands of fulfilling both their professional (inadequate time to provide quality care) and personal (inadequate time to care for their families) requirements and expectations (149). Our findings also show that health care providers were happy to promote Option B+ and they had high hopes that their patients would feel the same way. This could possibly be the reason why, despite the low satisfaction of health care providers with their overall work situation, they were still able to convey hope to their patients, making them feel satisfied with the care they received. On the positive side, the dissatisfaction expressed by PMTCT providers was not inherent in any individual characteristics but largely due to health system issues that possibly could be modified.

5.2.4 Factors associated with the intention of health care providers to leave the current job in PMTCT clinics

Health care providers (the great majority being nurses and midwives) who were unhappy with their job stability were almost four times more likely to think about leaving their job (OR 3.7, 95% CI 1.3-10.5). This finding was unexpected since we interviewed health care providers from public health care facilities, where employment is permanent and entitles employees to a retirement pension. Similar thoughts of leaving one's job were provoked by superiors who failed to recognize employees' work performance (OR 3.6, 95% CI 1.7-7.6) or

kept them uninformed about institutional performance (aOR 2.7, 95% CI 1.3–5.8). Leaders that value and recognize staff contributions tend to promote retention in the workplace (150-152). Tanzanian health care managers could possibly benefit from more training in positive feedback and be made more aware of good leadership styles that promote job satisfaction and retention among public employees.

5.2.5 Implications of the study findings

The overall findings from this study have implications not only on the efficiency but also on the effectiveness and sustainability of the Tanzanian health care system. The country already struggles with a severe shortage of human resources for health (81, 88) and has a pool of health care providers that cannot be rapidly expanded (90). Therefore, both short and long-term alternatives to promote health care providers' satisfaction and job retention are urgently needed to scale up and sustain high-quality PMTCT services in the country. A skilled and motivated health workforce is critical for achieving universal health coverage of health services, but workers continue to face increasing stress and insecurity (80). Thus, WHO suggests that in areas facing severe shortages of health care providers, innovations such as task-shifting can be used (109). Hence, in Paper III we evaluated the potential of task-shifting in improving efficiency in PMTCT service delivery.

5.3 THE POTENTIAL OF TASK-SHIFTING IN SCALING UP SERVICES FOR PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV: A TIME AND MOTION STUDY (PAPER III)

For Paper III, we observed a total of 1 121 PMTCT-related tasks including 179 patient-provider interactions, 57% from dispensaries and the remainder from health centres and hospitals.

5.3.1 Observed time spent in various PMTCT activities

Supporting earlier findings (79, 153), we also found that health care providers spend most of their time on activities involving communication and documentation. For example, during antenatal care, 44% of the 54 minutes spent on women's first ANC visit (the entry point into the PMTCT cascade), was spent on HIV testing and counselling, while 22% of the time was devoted to various documentation. Similarly, half of the 15 minutes (95% CI 14–17 minutes) spent during the ANC follow-up visits was devoted to communication such as counselling a woman on safe infant feeding and checking their ART adherence. About 44% of the ANC follow-up visit time was spent on documentation and ART refill, while only 6% of the time during this visit was spent on patient assessment.

The first postnatal mother-baby PMTCT visit took about half an hour on average (95% CI 26–32 minutes), with two thirds of the time being spent on infant HIV testing and counselling and documentation. Postnatal follow-up visits took about half as long as the first mother-

infant visit, 13 minutes (95% CI 11–16 minutes) on average, but health care providers still managed to prioritize patient counselling over the time they spent on documentation. The initial patient-provider meeting and the quality of communication during the first ANC visit which includes counselling, have also previously been suggested to be an important aspect of fostering the continuity of PMTCT care (154). Thus, relating to our earlier findings (Paper I), patients possibly had a reasonable time for quality communication with health care providers.

5.3.2 Potential for saving nurses' time by task-shifting some PMTCT activities to community health workers (CHWs)

With the introduction of Option B+, the workload increased in ANC/PMTCT facilities for two reasons. This demanded more time from existing health care providers. First, there was a change in eligibility criteria that resulted in an increase in the number of pregnant women living with HIV initiating ART in ANC/PMTCT facilities (155). Secondly, ANC/PMTCT facilities were given additional responsibilities to offer full ART services including clinical and immunological disease monitoring until the HIV status of infant was confirmed (77). In Malawi, which was the first country to spearhead the scale up of Option B+, they found it necessary to use a task-shifting model to address the challenge of staff shortages (155).

Realizing Tanzania's challenges ahead, this study tried to find out how useful it would be to task-shift some of the nurses' activities to CHWs. According to the WHO recommendations on task-shifting, CHWs could perform all tasks involving documentation and a large share of the communication tasks as well (109). Applying the WHO recommendations to our observation, we estimate that 94% of both the first and the follow-up visits at ANC could be task-shifted to CHWs. Similarly, 84% of the first postnatal PMTCT visit, and 100% of postnatal follow-up visits for PMTCT could be task-shifted from nurses to CHWs (**Figure 9**).

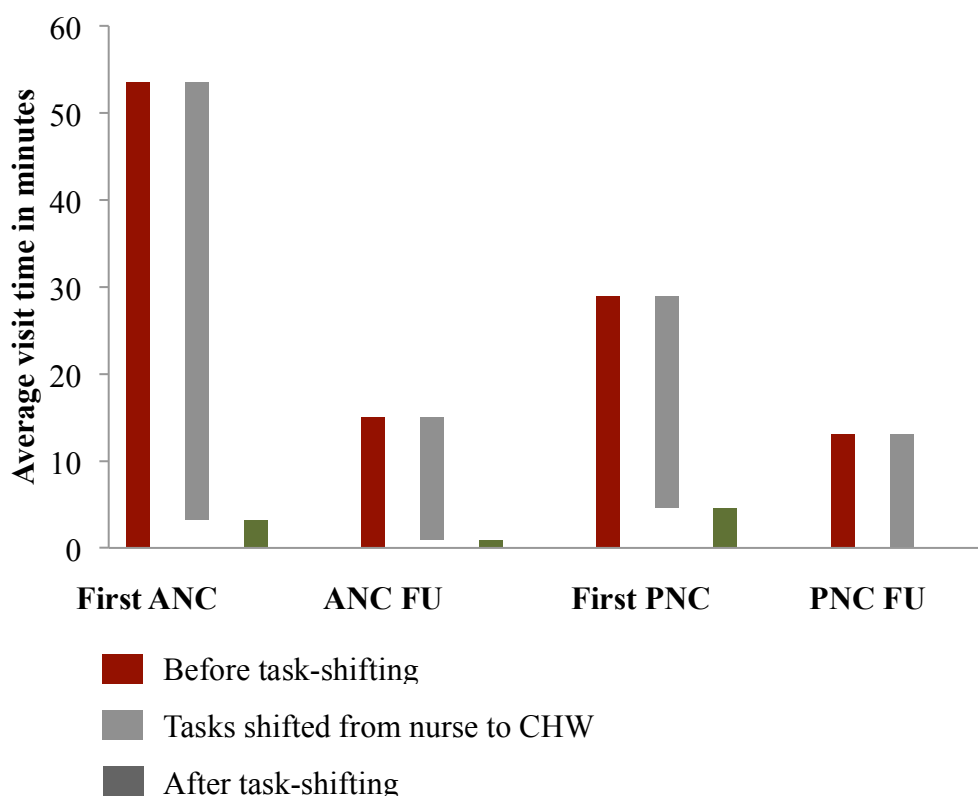


Figure 9: Task-shifting from nurses to community health workers

CHW = community health worker, First ANC = first antenatal care PMTCT visit, ANC FU = antenatal care PMTCT follow up visit, first PNC = first postnatal care PMTCT visit, PNC FU = postnatal care follow up visit.

5.3.3 Potential of saving per-patient cost by task-shifting some PMTCT activities to community health workers (CHWs)

Task-shifting could also have cost implications. Assuming that all tasks were indeed task-shifted according to the WHO recommendations, the average cost per visit could be substantially reduced. We estimated that the cost savings of task-shifting in PMTCT would be between US\$ 1.3 and 2.0 for the first ANC/ PMTCT visit, US\$ 0.4 and 0.6 for the ANC/PMTCT follow-up visit, US\$ 0.7 and 1.0 for the first PNC/PMTCT visits respectively and US\$ 0.4 and 0.5 for the PNC/PMTCT follow-up visit, based on our assumptions for CHW salary estimates (**Table 4**).

Table 4. Cost in US\$ per PMTCT visit

Visits	Observations	Mean cost before task-shifting (1)	Mean cost after task-shifting (2)	Mean cost after task-shifting (3)	Mean cost after task-shifting (4)
First ANC visit	36	2.27	0.96	0.85	0.28
ANC follow-up visit	69	0.65	0.27	0.24	0.08
First PNC visit	40	1.28	0.60	0.55	0.27
PNC follow-up visit	34	0.58	0.21	0.19	0.04

ANC = antenatal care, PNC = postnatal care.

(1): Calculated based on the weighted average salary of the publically employed nurse in Tanzania (nurse officer US\$ 495, enrolled nurse and nurse midwife US\$ 437). (2): Calculated based on the minimum wage for a formally trained health care provider in the public-sector health system in Tanzania (US\$ 172 per month). (3): Calculated based on community health worker salaries proposed in a previous study for Tanzania (US\$ 150 per month). (4): Calculated based on remuneration paid to lay health workers in another study (US\$ 30 per month).

One main barrier to task-shifting in PMTCT health care facilities in Tanzania is that the government has not employed CHWs yet and that it will take an initial investment to hire and train them before any cost savings could be realized. However, since it takes a shorter time and is less costly to train CHWs than nurses (156), it is plausible to assume that the saving will still be large by using a task-shifting model.

5.3.4 Implications of the study findings

Implementing the task-shifting model has potential for increasing efficiency in delivering PMTCT care in Tanzania. Task-shifting can allow nurses to invest time on specialized tasks that require more skills (114), such as the assessment of pregnancy-related risks, HIV clinical disease staging and supervision of CHWs.

The presence of CHWs in the clinic has been shown to reduce waiting time, improve patient flow, reduce the workload of health care providers (157) and improve adherence to ART (158). Thus, as we observed that a significant proportion of PMTCT tasks could be done by CHWs, task-shifting can enhance the scaling-up of PMTCT services in Tanzania and other similar settings, where the health care provider pool cannot be rapidly expanded (112). Linking to the previous two Papers (I and II), it is plausible to assume that task-shifting could reduce some of the challenges affecting the satisfaction of health care providers (unreasonable working hours) and patient satisfaction (long visit time).

5.4 HEALTH CARE COSTS ASSOCIATED WITH CLINIC VISITS FOR PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV (PAPER IV)

We also conducted a secondary analysis on de-identified data from a cohort of 2 309 newly diagnosed pregnant women living with HIV to study MTCT outcomes. We thereafter applied the unit time and costs obtained from Paper III to estimate the health care cost and the cost-effectiveness of optimal utilization of PMTCT clinics in relation to MTCT.

5.4.1 Patient characteristics

The medium age of the women in the cohort was 29.8 (± 5.7) years and the medium gestational age (GA) was 22 (± 7) weeks at the first clinic visit. The majority of the women were in the early WHO disease stage (89%) with an average CD4 cell count of ≥ 350 per μL (69%). About 72% of the women made their first ANC/PMTCT visit in their second pregnancy trimester and 95% reported good adherence to ART.

5.4.2 Clinic visits and patient outcomes

MTCT occurred in 2.8 mothers out of 100 during the first 12 weeks ($N=65/2309$; 95%CI; 2.2%-3.6%). The rates were higher, 4.8% (95% CI; 3.6%-6.4), when women made fewer than 4 ANC visits, but only 1.0 % (95% CI; 0.5%-1.7%) if they had attended ANC at least 4 times. As the number of ANC and PMTCT visits increased, fewer events of HIV transmission occurred, and no transmission was observed when more than seven visits were made (**Figure 10**).

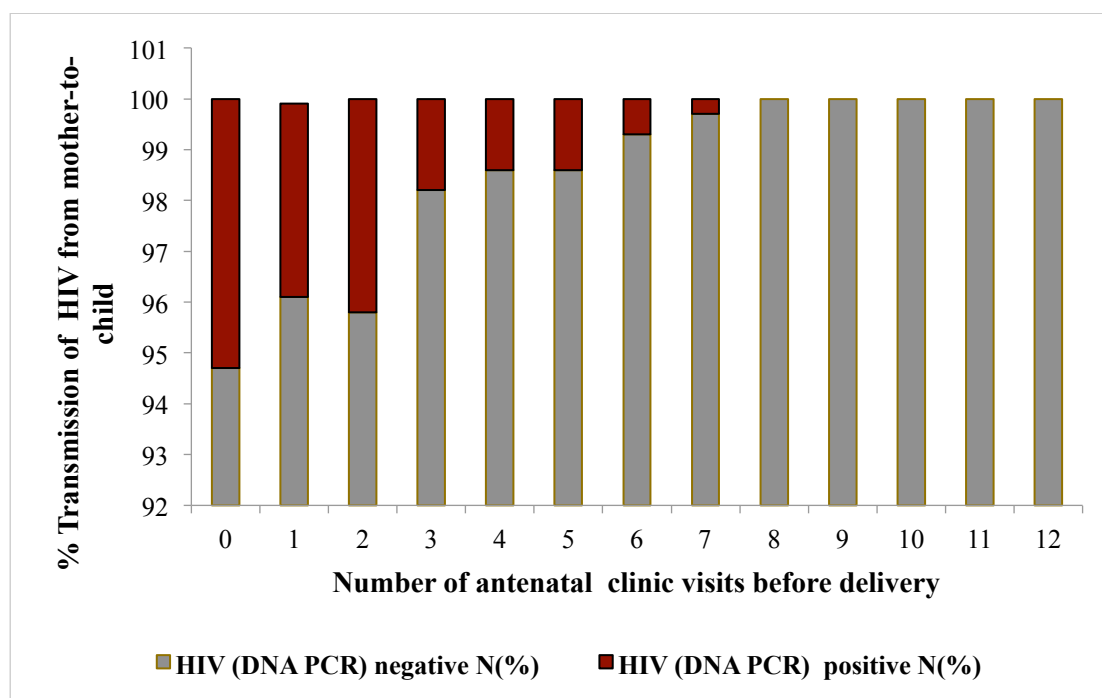


Figure 10. Number of antenatal care visits before delivery in relation to mother-to-child transmission of HIV at 6-12 weeks of life

These findings indicate that adherence to a minimum of 4 ANC visits has the potential to reduce MTCT, thus fewer than 4 ANC visits by a pregnant woman living with HIV can be used as an important warning sign. Such women should be candidates for more intense counselling. We also observed that mothers who transmitted HIV to their infants had a lower CD4 cell count (330 vs 485 cells per μL ; $p=0.005$), were more likely to be divorced or widowed ($p=0.030$), made their first ANC/PMTCT visit late (GA: 25.6 vs 21.9 weeks, $p=0.001$) and/or had initiated ART late (GA: 24.9 vs 22.3 weeks, $p=0.030$). Maternal immunosuppression is known to be an important risk factor for MTCT (159, 160). Women who were widows or divorced were significantly more likely to make fewer than 4 ANC visits as compared to women in a formal relationship (76% vs. 24%; $p=0.006$). These women may have poor access to ANC because of limited financial or social support compared to women in a formal relationship (161).

We also observed a significant association between making the first ANC/PMTCT visit late (27.8 vs 18.6 weeks, $p<0.001$) and the likelihood of making fewer than 4 visits compared to making at least 4 visits. In addition to a late first visit, women who made fewer than 4 visits also missed an average of 2 visits before delivery. Similarly, compared to women who attended ANC/PMTCT clinic at least 4 times, women who made fewer visits were more likely to have initiated ART late (27.9 vs 19.0 weeks, $p=0.001$). Furthermore, women who reported poor medication adherence (72.7% vs 27.3%, $p=0.02$) were more likely to have made fewer visits. Adherence to ANC visits has been shown to be related to both high adherence to ART, and retention in PMTCT care (162), the important factors associated with MTCT reduction. Thus, this can possibly explain our findings of less MTCT among women who made more visits. This is because during follow-up visits, clients are constantly reminded about the importance of adherence to ART and they would also get a refill of their ART supply. Other factors such as the mother's age, infant feeding practices and health care facility level were not significantly related to MTCT outcomes or to the number of clinic visits.

5.4.3 Cost and cost-effectiveness analysis

Overall, a total cost of 160225 US\$ was estimated to have been incurred for this cohort of 2 309 women, as calculated from the cost for health care providers' time spent on visits, laboratory tests and ART. The cost per patient was slightly higher for those who made at least 4 visits compared to those who made fewer than 4 visits (102.1 vs 90.1).

The incremental cost associated with making at least 4 clinic visits was 11100 US\$, equivalent to an incremental cost-effectiveness ratio (ICER) of 336.4 US\$ per MTCT case averted. The increased cost was a result of the additional service utilization related to more visits, which were missed by those who made fewer visits. For instance, those who made at least 4 visits received more ART prescriptions and had more interaction with health care providers. The estimates show that making at least 4 visits can potentially prevent more infections for an incremental cost of 336.4 US\$ per infection averted. This may appear high but is associated with preventing more MTCT and possibly reducing future treatment costs

that will be incurred in case MTCT occurs. For instance, the lifetime cost for one HIV-infected African child treated with a first-line ART regimen is estimated at \$41 350 per child (163). Furthermore, based on the procurement prices of ART in low-and-middle income countries as reported by WHO in 2013, the cost per person year of treating an HIV-positive child ranges from 300 US\$ for a child between 3 and 10 years and 438 US\$ for a child less than 3 years of age (128). Thus, although we did not model our estimates for a lifetime horizon of an HIV-infected child, our estimates suggest that encouraging women to make frequent PMTCT visits can be a cost-effective intervention. This also remained true after varying multiple input for cost of health care providers' time, laboratory test and medications within their lower and higher range values, the ICER was between 573.8 US\$ and 971.8 US\$ (Table 5).

Table 5: Costs and HIV infections averted for women under PMTCT Option B⁺ who made a minimum of 4 ANC visits compared to fewer than 4 visits in Dar es Salaam 2014-2016.

Components of PMTCT services	Unit cost US\$	Fewer than 4 visits (MTCT=46/949)		Minimum of 4 visits (MTCT=13/1275)	
		No of units	Cost US\$	No of units	Cost US\$
First ANC/PMTCT visit	2.27	949	2154.2	1275	2894.3
CD4 cell count tests	15.76	263	4144.9	504	7943.0
PMTCT follow-up visits	0.65	949	1233.7	1275	4143.8
Defaulter tracking	15	949	28470	0	0
Antiretroviral medication	8	949	30368	1275	61200
Hemoglobin test	0.85	144	122.4	226	192.1
Serum creatinine test	0.37	33	12.21	62	22.9
Alanine aminotransferase (ALT) test	0.88	37	32.56	78	68.64
Maternal Cotrimoxazole	0.6	949	3416.4	1275	4590
Total cost			69954.4		81054.7
Incremental cost (US\$)	11100.3				
ICER/MTCT averted (US\$)	336.4				

5.4.4 Implications of the study findings

Monitoring the number of ANC visits for pregnant women in PMTCT provides a simple tool to identify those most at risk of transmitting HIV to their infants. Thus, investing in earlier ANC visits (during the first trimester) and retention in PMTCT care for a pregnant woman living with HIV can prevent more infections and possibly reduce future treatment costs that will be incurred in case MTCT occurs.

6 CONCLUSIONS

- Patients receiving PMTCT care in Dar es Salaam were generally happy with the services they received and were only dissatisfied with these services if they perceived that health care providers had poor communication skills, low capacity to understand patient concerns, or if the hospital visit time was too long.
- More than half of health care providers in public health care facilities studied were dissatisfied with their current job, and turnover intentions were not unusual
- Being dissatisfied with the job and having turnover intentions was influenced by multiple factors such as low salaries, unreasonably long working hours, unclear job descriptions, poor safety measures, poor job stability, and inadequate supervision and feedback.
- Nurses working in PMTCT clinics spend a large proportion of their time on tasks that could be shifted to CHWs, which could also decrease the average cost per patient.
- Most pregnant women living with HIV do not attend ANC clinic in the first trimester of their pregnancy, which could increase the MTCT risk as well as future treatment costs.

7 RECOMMENDATIONS

- To address the existing PMTCT implementation and scale up challenges in Tanzania, the training and mentoring of health care providers and health managers as well as the service delivery models need to be improved to ensure:
 - Patient satisfaction and retention in care through a PMTCT delivery model that fosters good patient–provider interaction and cuts the waiting time at the clinic.
 - More attractive work environments through reasonable remuneration and working hours, clearer job descriptions, appropriate safety measures and job stability as well as better management performance.
- Shifting tasks from nurses to CHWs should be explored at least as a short-term alternative to reduce nurses’ workload, health care costs and to improve efficiency in PMTCT service delivery.
- To reach the target of EMTCT of HIV and to reduce future spending on HIV care in resource-limited settings, more efforts must be invested into encouraging pregnant women to seek ANC services earlier, preferably during their first trimester, to adhere to their antenatal and postnatal visits, and also for mothers living with HIV to stay on ART for life.

8 ACKNOWLEDGEMENTS

First and foremost, I would like to thank Almighty God for reasons too numerous to mention. For without his grace, mercy, and blessings, this achievement would not have been possible.

I take great pleasure in expressing my heartfelt and deep sense of appreciation to my main supervisor, Professor Anna Mia Ekström, a hard-working, intelligent and courageous person, from the Department of Public Health Sciences/Global Health at KI, Sweden, for her heartfelt support, creative suggestions, encouragements and guidance throughout my doctoral research training. She has been, a role model, an inspiration, and a friend, who has always been there for me, and in time of need, she offered me a shoulder to cry on. Her selfless time and care were sometimes all that kept me going, I consider myself very lucky to have had her as a main supervisor.

My sincere appreciation also goes to my main local supervisor from the Department of Obstetrics and Gynaecology at MUHAS, Tanzania, Professor Charles Kilewo, who has guided me throughout this journey, giving me positive feedback and encouragement.

I also wish to extend my gratitude to my co-supervisor, Professor Gunnel Biberfeld, a distinguished scientist from the Department of Public Health Sciences/Global Health at KI, Sweden, for her insightful guidance and for the valuable time she contributed to my work.

I express my gratitude to my co-supervisor, Professor Karim Manji, from the Department of Paediatrics and Child Health at MUHAS, Tanzania, for all her support, guidance and motivation during my PhD training. He was also happy to take over my clinical and teaching duties, when I was away for academic activities, something for which I am very grateful.

I also extend my sincere thanks to my co-supervisor, Professor Phares Mujinja, from the Institute of Public Health and Social Science, MUHAS, Tanzania. A health economist who provided valuable advice and support during the course of my research work, I am very grateful for his contribution.

I am also thankful to Professor Till Bärnighausen from the Institute of Public Health, University of Heidelberg, Germany; my co-supervisor and economic evaluation advisor. Professor Bärnighausen is a very busy person with a lot of responsibilities, sometimes hard to get, but even five minutes of his time has proven extremely useful.

I express my deep gratitude to the following for contributing significantly towards this achievement through various forms of support:

I am indebted to all the women and health care providers who agreed to participate in these studies as well as the research assistants. Their cooperation made it possible for me to write this thesis.

This work would not have been possible without the financial support of Sida, who funded my PhD training. I extend my sincere gratitude to Sida for this valuable contribution.

The administration of Muhimbili University of Health and Allied Sciences, where I work as a clinician and faculty member, has been very supportive in many ways to ensure that I completed my studies smoothly. They allowed me the time I needed for travel and to conduct the research studies that gave rise to this thesis.

Karolinska Institutet for its warm welcome and for offering me a chance to grow in the world of research academia. This opportunity will always be valuable to me and has also opened up many more research collaborations beyond my thesis.

I am grateful to all the people at the PHS department, including professors, assistant professors, administrators and many others, with whom I have had the pleasure to interact during my training at KI. They have all contributed to the growth in my research career.

My special thanks to Karin Båge, who has been willing to share office space with me most often and we have had fun and laughed together, I value our friendship a gift I will always treasure. Karin and Sara Causevic also took time to read my work and give me useful comments, which improved my work. I value their contribution to my work.

I would like to thank each of my fellow PhD students, whom I have been meeting frequently when in Stockholm, Tumaini Nagu, Theodora Mbunda, Lien La Thi Quynh , Fadhlun Alwy , Veronika Tirado, Uzma Khan, Muslima Ejaz, Galit Zeluf, Juliet Aweko, Dorcus Kiwanuka and Goodluck Lyatuu. I cherish their friendship, which touched me in many ways.

I express my gratitude to all the authorities in Muhimbili National Hospital and Dar es Salaam municipal hospitals and RCH clinics for their cooperation and granting me permission and space to conduct my research work in their clinics.

I express my thankfulness to the MDH organization for being a research collaborator that provided technical support and facilitated access to health care facilities and the database. Under the leadership of the late Dr Guerino Chalamilla, I received enormous support and he ensured that my PhD projects were smoothly integrated into their projects. He will greatly be missed. Then under the leadership of Mr Emilian Busara, I continued to receive the support I needed to complete my research work. I really appreciate the cooperation I received from everyone at MDH throughout the time we worked together.

I express my deep gratitude to all those who served as mentors at different stages of my doctoral training, including, just to mention a few, Prof Fred Mhalu, Prof Mohamed Bakari, Prof Eligius Lyamuya and Prof Said Aboud, who also coordinated the Sida HIV sub-programme research group at MUHAS. I owe a great debt of gratitude to them.

I thank all my colleagues in the neonatal unit of Muhimbili National Hospital for their understanding; I have frequently been away during my training and left them with a heavy workload of clinical duties. I owe them a lot.

I would like to extend my sincere thanks to my colleagues in the Department of Paediatrics and Child Health, MUHAS, especially the head of department, Dr Rodrick Kisenge, and all faculty members. They always agreed to take over my duties with an open heart during my absence, despite their hands being already full with their own teaching, clinical and

research responsibilities. Their great contribution to the success of my doctoral training is acknowledged and highly appreciated.

I cherish the friendship we have and take this opportunity to thank each one of my friends in Tanzania, including Dr Magdalena Lyimo, Dr Evelyne Assenga, Edgar Mushi, Rev. Kadiva, Dr Matilda Ngarina, Dr Patricia Munseri and many others for all their support and prayers.

I can barely find words to express my heartfelt thanks to Anna Berit Arvidson, together with her husband. Her presence, love and care always made me feel safe in Stockholm. She always welcomed me in her beautiful home; she always treats me well and offers me support in all possible ways making sure that I am safe and able to focus on my training. When I almost lost my life in Sweden, she was there to rescue me and continued to take care of me when I was admitted to the intensive care unit. She became my family and my supporter. She has also contributed to my achievement by providing constant advice on my research work. May The Lord bless her and all her family and keep them safe.

I thank all the doctors who treated me when I was admitted to Karolinska University Hospital, Solna, from the time I arrived at the emergency department and intensive care unit of. They are the reason I am alive and writing this thesis today. My special and warm thanks to Dr Anna Ågren, who has continued to follow up on my health progress to date.

It is with immense pleasure that I express my deep gratitude to my loving mother, Denengwabora, and my late dear father, Mr Elineema Naburi, for their unconditional love, upbringing and nurturing, support and prayers in every step of my life. I thank them for selflessly giving me the best of everything and putting up with my absence during the time they needed me around the most. They have always inspired me with their hard work, prayers and determination to educate their children, they are worth more than I can express on paper.

I express my sincere, heartfelt and never-ending love and respect towards to my siblings, Grace, Alfred, Cuthbert, Felix, Edith and Gareth. They have all made a tremendous contribution in helping me reach this stage in my life, I feel so honored to be part of such a wonderful family

I am deeply indebted to my loving and special niece, Natasha, a smart girl with a strong heart. She has always inspired me with her faith, together with my other dear nieces, Nuru, Neema, Elizabeth, Debora, Aileen, Aika, Erica, Quintella, Dora, Charity and Cynthia, and my nephews, Bright, Amani and Quinelle, they have all been a blessing to me. I thank them all for their prayers and for taking a good care of my home while I was away.

I extend my thanks to all the members of the Naburi family, for their concern, prayers and good wishes. They have always been there for me when I needed them, we cried together, and have grown stronger together when we lost our dear uncles, aunties and cousins, the family tragedies that occurred during my doctoral training. We have also laughed together during the good times. I am indebted for their unconditional love and support

There are so many others who have contributed towards this achievement in one way or another and may have unintentionally been left out. I sincerely thank all of them for their contribution and prayers.

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